THE JOURNAL
Volume 19, No. 1
pp. 1-28

CERAMIC ABSTRACTS
Volume 15, No. 1
pp. 1-50

AMERICAN CERAMIC SOCIETY

JANUARY • 1936

MONTHLY PUBLICATIONS DEVOTED TO THE ARTS AND SCIENCES RELATED TO THE SILICATE INDUSTRIES

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Vol. 19 January, 1936 No. 1

THE JOURNAL OF THE AMERICAN CERAMIC SOCIETY

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Editorial and Advertising Offices:
The American Ceramic Society, 2525 North High St., Columbus, Ohio

Publication Office: 20th and Northampton Sts., Easton, Pa.

Entered as second-class matter at the post office at Easton, Pa., under the act of March 3, 1879. Published monthly.
Subscription fifteen dollars ($15.00) a year. Single numbers $1.50
(Foreign and Canadian postage, 50c additional on subscriptions)
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SOLID REACTIONS AT 1000° TO 1200°C BETWEEN MgO OR BeO AND Ni, Fe, Cr, Mn, AND THEIR OXIDES*

By Louis Navias

Abstract

The elements, Ni, Fe, Cr, and Mn, and their oxides, NiO, Fe_2O_3, Cr_2O_3, and MnO_2, in a finely divided state, were brought into contact with granular fused MgO in loose form and in pressed disks and also into contact with slabs of high-fired MgO and BeO. The maximum temperatures reached were 1000°C, 1100°C, and 1200°C in air firings. The degree of reaction was noted by the extent of discoloration of the MgO and BeO near the contact material. Ni showed the least reactivity, Fe and Cr came next, and Mn showed the most reaction. The oxides gave the same order of reactivity, NiO, Fe_2O_3 and Cr_2O_3, and MnO_2, the most. The elements in oxidizing caused more reaction than their oxides in all cases. There was less reaction with BeO than with MgO for corresponding contact material.

Firings were also made with these elements and oxides in contact with pressed disks of fused MgO but in a hydrogen atmosphere. Ni and Fe showed no reaction; Cr, a very slight reaction; and Mn, slightly more reaction. NiO and Fe_2O_3 were reduced to their elements without reaction, whereas Cr_2O_3 did not reduce and gave no reaction. MnO_2 became semi-sintered and gave a very slight reaction.

Other experiments were made by passing air or N_2, dry or through water, into mixtures of granular fused MgO and Mn, MnO_2, or Cr, respectively. At 1200°C, reaction was greatest with moist air.

I. Introduction

In one type of heating element, a tube of metal supports internally a long helix of nickel-chromium resistance wire, the intervening space being tightly packed with particles of fused MgO. The tube of metal or sheath is an alloy of Ni, Cr, and Fe. Since the helix may run as hot as 1000°C, there are possibilities for solid reactions to occur between fused MgO and the elements (or their oxidized products) of the metal parts.

The fused MgO is made on a commercial scale by maintaining an arc between carbon electrodes in a mass of calcined magnesite. The fused MgO is essentially crystalline, consisting of periclase with anisotropic inclusions of the compounds formed with MgO and the impurities, such as SiO_2, Al_2O_3, CaO, and Fe_2O_3.

II. Mixed Powder Experiments with Fused MgO

Fused MgO, 40- to 100-mesh in size, was mixed with small quantities of adulterant and placed in a quartz-glass boat, 15 inches long and 3/4 inch across the open top. The boat was placed in a long 1-inch quartz-glass tube heated in a platinum-wound tube furnace. The MgO charge was so located that it extended from the relatively cold mouth to the hot center. About 4 inches of the boat lay in the hot zone. Changes in color due to temperature could thus readily be distinguished.

The gas, either air or nitrogen and either dry or wet by bubbling through water, was passed through the tube the entire time the charge was in the furnace. The adulterants or contact materials were powders (finer than 200-mesh).

Starting with a cold furnace, the maximum temperature was reached in about 4 hours and maintained for 3 to 4 hours. On the shut-down, cooling was rapid. (See Tables I, II, and III.)

(1) Summary on Mixed Powder Experiments

At 1000°C, the contact reaction between Mn and fused MgO was negligible, whereas at 1200°C the reaction was decided. The Mn was oxidized in the process, picking up O_2 from the nitrogen and from the air.

At 1000°C and 1100°C, Cr showed very feeble reaction and at 1200°C, a quite decided reaction. Cr oxidized in the process.

At 1000°C, MnO_2 gave only slight reaction with fused MgO.

Wet air and N_2 appeared more conducive to increased reaction than dry gases.

III. Contact Experiments with Pressed Blocks of Fused MgO

Fused MgO, 40- to 100-mesh, was pressed into disks with starch paste and fired in a hydrogen-protected molybdenum-wound furnace to

* Presented at the Annual Meeting, American Ceramic Society, Buffalo, N. Y., February, 1935 (Refractories Division).

TABLE I

MIXED POWDERS WITH FUSED MgO

Expt. No.	Mn addition (%)	Atmosphere	Temp. at hottest part (°C)	Appearance of charge taken from hottest part	
				Color	Reaction on MgO
1	—	Dry N_2	1000	Light tan	None
2	0.2	" "	"	Dark tan	A few particles discolored
3	"	" "	"	" "	" " " "
4	"	Wet N_2	"	" "	" " " "
5	"	Dry air	"	" "	Very slight diffused color throughout
6	"	Wet air	"	" "	Slightly more diffusion than in 5
7	"	Dry N_2	1200	Dark tan with small light areas	Mn particles black, rounded; reaction restricted to some particles; discoloration around Mn restricted
8	"	Wet N_2	"	Speckled tan	Similar to 7, but with more reaction evident
9	"	Dry air	"	" "	Black reaction zones; diffusion quite noticeable
10	"	Wet air	"	Dark tan	" " " "

NOTES: At 1000°C there was no visible reaction between Mn and MgO. The fused MgO is itself a light tan color and the admixture of Mn causes it to become a darker tan. In general, the reaction was very slight. Under the microscope, slight discolorations of some MgO particles were noticeable. The most reaction occurred with wet air, less with dry air, and least with wet or dry N_2. The particles of Mn maintained their angular shape and were well dispersed. As fused MgO forms hydroxide slowly in water, some reaction might be expected with water-vapor at high temperatures.

At 1200°C, there were very decided signs of reaction. The Mn particles, instead of being angular, were now black globules adhering tenaciously to the MgO particles. The MgO particles in direct contact with Mn are black. The reaction zones are usually circular and the color ranges outwardly from black to brown, fading to yellow. The rest of the MgO granules have a definite tinted appearance. The reaction was strongest with dry and wet air, less so with wet N_2, and least with dry N_2.

Under the conditions of experiment even with dry N_2 from a tank, the Mn has an opportunity to pick up some oxygen. The melting point of MnO is given as (*a*) 1650°C* and as (*b*) 1785°C by White, Howat, and Hay†, and that of Mn_3O_4 is given as 1560°C by Wartenberg and Reusch.**

In the same paper,** the authors give the binary system, Mn_3O_4–MgO, in which no eutectic is apparent. They state that mixed crystals are formed. It is hardly likely that the reactions noted here are due to low-melting eutectics. The melting point of Mn is 1260°C.‡

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* International Critical Tables, Vol. 1, p. 127.

† J. White, D. D. Howat, and R. Hay, *Jour. Roy. Tech. Coll.*, **3**, 231–40 (1934).

** H. v. Wartenberg and H. J. Reusch, "Melting Diagrams of Refractory Oxides, VI," *Z. anorg. allgem. Chem.*, **208** [4] 380 (1932); *Ceram. Abs.*, **12** [2] 63 (1933).

‡ International Critical Tables, Vol. 1, p. 104.

TABLE II

MIXED POWDERS WITH FUSED MgO

Expt. No.	MnO_2 addition (%)	Atmosphere	Temp. at hottest part (°C)	Appearance of charge taken from hottest part	
				Color	Reaction on MgO
11	0.2	Wet air	1000	Very dark tan	Slight
12	"	Dry air	"	" " "	Very slight
13	"	Wet N_2	"	Tan	" "
14	"	Dry N_2	"	"	None

NOTES: The material in the hot zone (5-inch length) is colored a very dark tan. Under the microscope, no particles of MnO_2 are visible and about one-half of the MgO particles are uniformly colored a tan-yellow. The middle 4-inch section of the boat is visually yellow-brown. There are present individual MnO_2 particles. No reaction is discernible. The cold 6-inch section is visually quite a dark tan, similar in appearance to the hot section. The microscope shows no reaction of the many black MnO_2 particles with MgO, and the color is due to the blending of materials.

With dry air and wet N_2, the reaction was not so great as with wet air but nevertheless definite. No reaction was noticeable with dry N_2.

1600°C. In this process, all organic matter was removed. Due to the reduction of slight amounts of iron oxide, the disks were white, verging on gray. The contact material, element or oxide, was spread on top of the MgO disk and fired under the conditions specified.

All firings were started cold, taking four hours to reach 1200°C, maintained for 4 hours, and the specimens were allowed to cool rapidly with the furnace. For the air firings, a platinum-wound furnace was used, and only the air atmosphere of the furnace was used. For the reducing atmosphere, the hydrogen atmosphere of the molybdenum-wound furnace was adequate.

TABLE III

MIXED POWDERS WITH FUSED MgO

Expt. No.	Cr addition (%)	Atmosphere	Temp. at hottest part (°C)	Appearance of charge taken from hottest part	
				Color	Reaction on MgO
15	0.2	Wet air	1000	Tan	Slight greenish discoloration on a few particles
16	"	" "	1100	Light tan; streaked	Slight yellow-greenish discoloration on some particles
17	"	Dry air	"	Light tan; black specks	" " " " " "
18	"	Wet N_2	"	Bleached; spotted brown	" " " " " "
19	"	Dry N_2	"	Light tan	" " " " " "
20	"	Wet air	1200	" "	Cr particles, rounded and black; reaction rims on MgO opaque brown
21	"	" "	"	" "	" " " " " "
22	"	Wet N_2	"	" "	" " " " " "

NOTES: The reaction with MgO at 1000°C was limited to a faint greenish discoloration. At 1100°C, the discoloration was yellow-greenish on a greater number of particles. At 1200°C, with either wet N_2 or wet air, the reaction was quite pronounced. The Cr particles had become rounded in shape and black in color and bonded MgO particles together. The fused MgO near the contact was discolored an opaque brown which became a transparent brown and finally a light yellow-brown at the edge of the reaction rim.

While Cr has a high melting point* (1615°C), it oxidizes rapidly at lower temperatures. In fact, Cr is an excellent scavenger for traces of oxygen in hydrogen at the temperatures of these experiments, and it is to be expected that a chromium oxide will be formed on the surface at least of the fine Cr particles. Cr_2O_3 has a melting point of 1900°C.†

* International Critical Tables, Vol. 1, p. 105.
† *Ibid.*, p. 132.

TABLE IV

ELEMENTS Ni, Fe, Cr, AND Mn, FIRED IN AIR AT 1200°C (FUSED MgO BLOCKS)

Expt. No.	Contact material	Appearance of contact material		Reaction on fused MgO disk
		Before firing	After firing	
23	Ni	Gray-brown	Olive green, hard mass	None; no discoloration on MgO at contact with green oxide
24	Fe	Black	Gray-black, hard mass	Black particles surrounded by deep brown stain on MgO
25	Cr	Silver gray-black	Dull brown-black hard mass	Black particles, surrounded by greenish- and brown-reaction rims
26	Mn	Silvery	Silver-black, sintered solid	Wide diffuse area of brown stain on MgO around sintered particles
27	Ni–Fe		Dead black, semi-sintered	Brown diffuse stain quite wide around sintered particles
28	Ni–Cr		Brown-black, semi-sintered	Brown-black diffused stain
29	Ni–Mn		Silver-black, sintered solid	Brown diffusion, slight
30	Fe–Cr		Brown-black, semi-sintered	Waxy brown, diffuse stain, quite wide; also greenish stain
31	Fe–Mn		Silver-black, sintered solid	Brown diffusion, slight
32	Cr–Mn		Black, sintered solid	Decided diffusion; waxy brown stain
33	Ni–Fe–Cr		Gray-black, many sintered granules	Greenish stain, not diffuse

NOTES: The elements oxidized in the process of heating. Ni showed no reaction; Fe and Cr, some reaction; and Mn, more reaction. Mn particles were sintered solid and made a wide diffuse area of brown stain on the underlying MgO. The order of increasing reaction was Ni, Fe and Cr, and Mn.

Binary mixtures (and one ternary mixture) of equal weights of these four elements were also fired on fused MgO blocks at 1200°C. In the binary mixtures, those containing Fe and Cr maintained some reaction, whereas those containing Mn, such as Ni–Mn and Fe–Mn, showed only slight coloration and diffusion. Cr–Mn was exceptional in having a decided reaction. In general, the amount of reaction with these binary mixtures was less than would have been expected from the single elements.

TABLE V

OXIDES NiO, Fe_2O_3, Cr_2O_3, AND MnO_2, FIRED IN AIR AT 1200°C (FUSED MgO BLOCKS)

Expt. No.	Contact material	Appearance of contact material		Reaction on fused MgO disk
		Before firing	After firing	
34	NiO	Olive green	Light green, loose powder	None; no discoloration on MgO at contact with green oxide
35	Fe_2O_3	Brick red	Gray-black, caked	Black particles surrounded by narrow area of red-brown stain
36	Cr_2O_3	Dark green	Very dark green, loose powder	Green mass surrounded by glossy brown tinted discoloration on MgO close to Cr_2O_3 particles only
37	MnO_2	Blue-black	Sintered black	Wide area of waxy brown discoloration around sintered MnO_2; some MgO granules close to MnO_2 dark brown in color
38	NiO–Fe_2O_3	Tapestry brick red	Slightly hard aggregates, blue-black	Slight brown diffusion around some particles
39	NiO–Cr_2O_3	Grass green	Soft aggregates, green-black	Green-brown stain; some MgO particles appear greenish throughout
40	Fe_2O_3–Cr_2O_3	Cocoa-brown	Brown-black	Brown stain around some particles; diffusion slight
41	NiO–Fe_2O_3–Cr_2O_3	Yellow-brown	Soft aggregates, brown-black	Slight brownish diffusion

NOTES: NiO showed no reaction with fused MgO. Both Fe_2O_3 and Cr_2O_3 became darker in color and reacted somewhat with the MgO. Fe_2O_3 gave a narrow brown band in contact with fused MgO. Microscopically, the discoloration was seen to be red-brown, fading rapidly to light shades. MnO_2 discolored the MgO block a waxy brown over a wide area. Some MgO particles were completely discolored a dark brown.

TABLE VI

ELEMENTS Ni, Fe, Cr, AND Mn FIRED IN HYDROGEN AT 1200°C (FUSED MgO BLOCKS)

Expt. No.	Contact material	Appearance of contact material		Reaction on fused MgO disk
		Before firing	After firing	
42	Ni	Silver-gray powder	Clean, bright metal	No reaction
43	Fe	Gray-black powder	Clean, bright metal	No reaction
44	Cr	Silver-gray powder	Gray-black	Delicate green contact area, very slight
45	Mn	Bright metal	Dark green-black; sintered solid	Slight greenish stain limited to area very close to Mn particles
46	Ni–Fe	—	Metallic gray; sintered solid	No reaction; no diffusion of color; MgO very white
47	Ni–Cr	—	Green-black; sintered	No reaction; no diffusion; MgO very white
48	Ni–Mn	—	Green-black; sintered solid	Slight greenish diffusion
49	Fe–Cr	—	Green-black; sintered	No reaction; no diffusion of color; MgO very white
50	Fe–Mn	—	Blue-black; sintered solid	No reaction; some MgO particles had a greenish uniform tint
51	Cr–Mn	—	Light green-black; sintered solid	Slight green stain
52	Ni–Fe–Cr	—	Gray-black; sintered balls	No reaction; no diffusion of color; MgO very white

NOTES: Ni and Fe remained in the reduced metallic condition and showed no reaction with fused MgO. Cr turned gray-black in color; otherwise showed no change. Cr, in contact, left a very faint greenish tint on the MgO. Mn turned to a dark green-black, sintered solid. Microscopically, some globules could be seen. A slight greenish stain was restricted to the immediate vicinity of the particles. The order of increasing reactivity was Ni and Fe, Cr, and Mn.

Six binary mixtures (and one ternary mixture), containing equal weights of the elements, were also tried. In general, the metals tended to react with each other, forming sintered masses. The reaction with the fused MgO, however, was quite slight, less than might be expected from the reactivity between the elements (and between their oxidized products).

These block experiments have the advantage over the mixed-powder experiments in that the contact zones between contact material and MgO can be examined with the microscope without disturbing the particles. (Tables IV, V, VI, and VII.)

(1) Summary on Fused MgO Block Experiments

In air firings, the order of increasing reactivity was Ni, Fe and Cr, and Mn for both the elements and their oxides. The elements, in oxidizing, gave more reaction than the initial

TABLE VII

OXIDES NiO, Fe_2O_3, Cr_2O_3, AND MnO_2 FIRED IN HYDROGEN AT 1200°C (FUSED MgO BLOCKS)

Expt. No.	Contact material	Appearance of contact material		Reaction on fused MgO disk
		Before firing	After firing	
53	NiO	Yellow-green	Silvery metal; sintered	No reaction
54	Fe_2O_3	Red	Blue-black metal; sintered	No reaction
55	Cr_2O_3	Dark green	Soft particles; dark green	None; no discoloration
56	MnO_2	Blue-black	Dull semi-sintered; green-black	Faint brown-green discoloration; very slight reaction
57	NiO–Fe_2O_3		Metallic gray; sintered solid	No reaction; no stain; MgO very white
58	NiO–Cr_2O_3		Light green, soft powder containing metal	No reaction; no stain; MgO very white
59	NiO–MnO_2	Gray-black	Mottled brown; sintered solid	Greenish tinge to MgO under contact material, consisting of sintered mass containing metallic globules; MgO very white
60	Fe_2O_3–Cr_2O_3		Brown-green; soft powder containing metal	No reaction; no stain; MgO very white
61	Fe_2O_3–MnO_2	Brick red	Blue-black; sintered solid	Near contact material; some MgO particles are semi-opaque; a few cases coated with tiny elongated crystals; otherwise no reaction
62	Cr_2O_3–MnO_2	Very dark green	Soft powder; light green	No reaction; no discoloration; MgO very white
63	NiO–Fe_2O_3–Cr_2O_3		Dark green; soft powder	No reaction; no stain; MgO very white

NOTES: NiO and Fe_2O_3 were reduced to their elements in a hydrogen atmosphere as low as 700°C and tended to sinter with increasing temperatures. In this process, the MgO was unaffected. Cr_2O_3 resisted reduction and yielded no reaction with the fused MgO. MnO_2 changed to a semi-sintered mass and yielded a faint brown-green discoloration on the MgO.

By mixing the oxides in equal proportions to form six binary and one ternary mixture, there were discolorations with fused MgO only where MnO_2 was present with NiO or Fe_2O_3. In spite of marked changes in these contact mixtures, the reactions with MgO were slight. The combination of Cr_2O_3–MnO_2 was run twice to make sure of the results, for the mixture in both cases was soft and green in color. There was no visible evidence of the presence of the dark MnO_2, and there was no reaction with the fused MgO. In general, the mixtures had less reactivity than the individual oxides.

oxides themselves. Ni or NiO showed no reaction. In the H_2 firings, Ni and Fe and their oxides gave no reactions, remaining as (or being reduced to) their elements. Cr was able to oxidize and yielded a very slight reaction, whereas Cr_2O_3 did not. Mn was oxidized, and MnO_2 changed its physical form, both conditions yielding more reaction than Cr.

In air, the binary mixtures of the elements and of the oxides gave slight reactions, but less than would be expected from the individual contact materials. Cr–Mn gave a decided reaction. In the H_2 firings, only mixtures containing Mn or MnO_2 showed any reaction; Cr_2O_3–MnO_2, however, was an exception.

IV. Contact Experiments with Extruded Slabs of High-Fired MgO and BeO

As the impurities in the fused MgO averaged several per cent and the grain size was rather coarse (40- to 100-mesh), it was decided to determine some of the reactions with a finely divided, fairly pure grade of MgO and to compare the results with BeO, which appears above MgO in the Periodic Table and related to it.

Chemically prepared MgO, analyzing SiO_2 0.10%, Al_2O_3 + Fe_2O_3 0.14%, and CaO trace, was fired as powder to 1600°C in a hydrogen molybdenum-wound furnace to shrink it. With starch paste, it was then extruded into a ribbon 1 inch wide and $^1/_4$ inch thick. Slabs cut from the ribbon were fired in H_2 to 1600°C. The MgO slabs have a very fine structure and are dead white in color. They consist of an aggregate of very small periclase crystals.

A chemically pure BeO, with traces of Al_2O_3 and CaO, was treated in the same manner, namely, a 1600°C firing, extrusion into a ribbon, and firing of the BeO slabs at 1600°C. The BeO slabs are gray-white in color and consist of fine-grained aggregated crystalline material.

The powdered elements and oxides used for the contact materials were of good chemical stock grades.

For the contact experiments, slabs of MgO and BeO, generously sprinkled with powder of the

TABLE VIII

ELEMENTS Ni, Fe, Cr, AND Mn FIRED IN AIR AT 1200°C (HIGH-FIRED MgO AND BeO)

Expt. No.	Contact material	Oxide slab	Change in contact material	Reaction on oxide slab	
				Inner reaction area	Outer reaction area
64	Ni	MgO	Green	Green	Light green
65	Ni	BeO	"	None	None
66	Fe	MgO	Black	Red-brown	Light yellow-brown
67	Fe	BeO	"	Light gray	None
68	Cr	MgO	"	Brown-black waxy luster	Blue-green fading to yellow
69	Cr	BeO	"	Light green	None
70	Mn	MgO	"	Very dark brown-black waxy luster	Light brown
71	Mn	BeO	"	Light red-brown	Light red-brown

NOTES: The firings oxidized the metal powders, Ni turning green, and the Fe, Cr, and Mn turning various shades of black. The MgO slabs changed from a pure, dead white to slight gray, whereas the BeO slabs turned from a slight gray to a pure white. The oxidized Ni was massed together; the oxidized Fe and Cr sintered with rounded corners, and the oxidized Mn sintered well into black, hollow spheroids which stuck tenaciously to the MgO and BeO. The area around the powders for convenience was divided into two parts, the inner and outer reaction areas, as shown in Table VIII. Comparing the elements on MgO alone, Ni had the least reaction, then came Fe and Cr, and finally Mn with definitely more reaction. On BeO, the same order of reaction held. Comparing MgO and BeO, in all four cases there was less reaction with BeO than with MgO. With MgO the inner reaction areas were darker in color and wider; similarly the outer reaction areas were more noticeable. The only example of no reaction was Ni on BeO. With Fe on BeO, there was a slight graying close to the powder.

TABLE IX

OXIDES NiO, Fe_2O_3, Cr_2O_3, AND MnO_2 FIRED IN AIR AT 1200°C (HIGH-FIRED MgO AND BeO)

Expt. No.	Contact material	Oxide slab	Change in contact material	Reaction on oxide slab	
				Inner reaction area	Outer reaction area
72	NiO	MgO	Green	Green	None
73	"	BeO	"	None	"
74	Fe_2O_3	MgO	Brown-black	Red-brown	Light yellow-brown
75	"	BeO	" "	None	None
76	Cr_2O_3	MgO	Green	Brown-black	Green
77	"	BeO	"	Light green	None
78	MnO_2	MgO	Black	Brown-black	Light brown
79	"	BeO	"	Light red-brown	Light red-brown

NOTES: The firings left the NiO and Cr_2O_3 essentially unchanged in their characteristic green colors. They were only slightly clustered. Fe_2O_3 turned from red to brown-black and was more sintered. MnO_2 remained black and well sintered, but not as noticeable as Mn (Nos. 70 and 71, Table VIII). The MgO slabs turned slightly gray, and the BeO slabs changed to a pure white.

The state of reaction and the colors involved are given in Table IX. On MgO, NiO showed the least reaction, then came Fe_2O_3 and Cr_2O_3, with slightly more reaction, and MnO_2, with still more reaction, as evidenced by microscopic examination of the surrounding reaction areas. On BeO, the same order of reaction held. Comparing MgO with BeO in each case there was more reaction with MgO than with BeO. Neither NiO nor Fe_2O_3 showed any reaction with BeO, taking as evidence the lack of any color change in the BeO close to the contact oxides.

element or oxide, were placed side by side in the furnace. The firing schedule was 4 hours to 1200°C, maintained at 1200°C for 4 hours, and cooled with the furnace. The atmospheric conditions of the platinum-wound furnace only were involved. (See Tables VIII and IX.)

(1) Comparison between Elements and Oxides Fired in Air at 1200°C

It was interesting to compare the reactivities between the elements as they oxidized in contact with MgO or BeO and the oxides of these same elements. In most cases, the reaction from the element was greater than that of the corresponding oxide, the only exception being with Ni and NiO on BeO, where there was no reaction in either experiment. These differences in reaction and in the resulting diffused areas of color were quite striking and accentuated the finding that the process of oxidation increased the rate of reaction with the underlying oxide.

V. General Conclusions

(1) In an oxidizing atmosphere at 1200°C (*a*) on MgO, the reaction increased in the order NiO, Fe_2O_3 and Cr_2O_3, and MnO_2; (*b*) on BeO, the reaction increased in the order NiO (none), Fe_2O_3 and Cr_2O_3, and MnO_2; (*c*) there was more

reaction on MgO than on BeO in corresponding cases for (*a*) and (*b*); (*d*) on MgO, the reaction increased in the order, Ni, Fe and Cr, and Mn; (*e*) on BeO, the reaction increased in the order, Ni (none), Fe and Cr, and Mn; (*f*) there was more reaction on MgO than on BeO in corresponding cases for the elements in (*d*) and (*e*); in these cases all the elements become oxidized, at least on the surface, and it must be recognized that the conditions of contact with MgO and BeO were different than in cases (*a*) and (*b*) where the oxides were used; and (*g*) the elements in oxidizing gave more reaction than the corresponding oxides.

(2) In a reducing (H_2) atmosphere at 1200°C on fused MgO (*a*) the readily reducible oxides, NiO and Fe_2O_3, gave no reaction; Cr_2O_3 did not reduce and gave no reaction; MnO_2 became semi-sintered and yielded a slight reaction; (*b*) the elements, Ni and Fe, stayed metallic and had no effect on the MgO; Cr and Mn oxidized and showed very slight reactivity; (*c*) mixtures of oxides gave less reaction than the individual oxides; wherever MnO_2 was present, there was some reaction, except with Cr_2O_3–MnO_2, where reaction is doubtful; and (*d*) mixtures of elements gave less reaction than the individual elements; where Mn was present slight reaction was found.

(3) When air or nitrogen was passed, dry or moistened with water, through a mixture of fused MgO with Mn, MnO_2, or Cr powders at 1200°C, most reactivity was found when the wet air was used.

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ADVANCED AND REFINED TECHNIQUE IN THE PETROGRAPHIC STUDY OF CRYSTALLINE REFRACTORIES*

By R. B. McCormick

Abstract

The new technique for the determination of the refractive indices of minerals, as developed by R. C. Emmons of the University of Wisconsin, is described. The paper contains a discussion of immersion media and a description of the double-variation apparatus, the modified universal stage, and the smithsonite refractometer. Application of the technique to crystalline refractories is considered.

I. Introduction

This paper is a review of the technique developed by Emmons for determining the refractive indices of minerals. Many of the technical details contained in the original papers[1] have been omitted in order to present the subject in perspective. The application of this technique to the field of ceramics is included in the discussion.

II. The Double-Variation Method of Mineral Determination

The development of this method of mineral determination was inspired by a desire for greater accuracy in refractive-index measurements; in Dr. Emmons' own words, an accuracy "required by the greater detail with which minerals are becoming known and also by the realization of the importance of small variations in refractive index, especially with regard to their bearing on differences in chemical composition."

In the study of refractive indices by the modern petrographic microscope, white light has been utilized, that is, light of all visible wave-lengths from about 4500 to 7000 Å. The mean value of this light is usually conceded to be that of the wave-lengths from 5450 to 5550 Å. The dispersion, however, of mineral substances, or, in other words, their change in refractive index with vary-

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* Presented at the Annual Meeting, American Ceramic Society, Buffalo, N. Y., February, 1935 (Refractories Division).

[1] (*a*) R. C. Emmons, "Double-Dispersion Method of Mineral Determination" (preliminary paper), *Amer. Mineralogist*, **13** [10] 504–15 (1928).

(*b*) "Double-Variation Method of Refractive Index Determination" (second paper), *ibid.*, **14** [11] 414–26 (1929).

(*c*) "Modified Universal Stage," *ibid.*, **14** [12] 444–61 (1929).

(*d*) R. C. Emmons and E. F. Williams, "A High Index Refractometer," *Jour. Sed. Petrology*, **4** [1] 32–35 (April, 1934).

ing wave-length of light, suffices to show the inaccuracies of index measurement with white light. Further, the dispersive power of liquids is greater, in general, than that of solids. If then, a mineral grain is immersed in a liquid, the refractive index of which is near that of the mineral, it is possible to match the index of the two by changing the wave-length of light used. The refractive index of the mineral may be found by measuring the index of the liquid for that wave-length of light. Further, the refractive index of a liquid varies greatly with change in temperature, increasing with decrease in temperature and decreasing with increase in temperature. On the other hand, the temperature coefficient of the refractive index of minerals, with few exceptions, is very low. It is possible, then, to match the index of a liquid with that of a mineral for a given wave-length of light by varying the temperature of the liquid. These factors, *i.e.* (1) the difference in dispersive power of liquids and solids and (2) their variation in refractive index with both light wave-length and temperature change, form the basis of the double-variation method of index determination.

Liquids with a high dispersion would naturally be the most satisfactory for this method since the limits imposed by such liquids are considerably widened. Accordingly, a set of thirteen liquids was selected, all of which have high dispersion and high-temperature coefficients of refractive index; they cover an index range from 1.40 to 1.78 without any interruption and in places with considerable overlap. Table I lists these liquids and their refractive indices.

A set of temperature-variation liquids, ranging in index from 1.43 to 1.75, has been developed for use in laboratories where a monochromator is not available. The index-measuring procedure is the same as that of the double-dispersion method except that a source of light of definite wave-length, such as a sodium flame, is used, and variation of the index of refraction of the liquid is obtained by change of temperature only. Eighteen of these liquids are single compounds and two are carefully selected mixtures of approximately equal volatility, since no single compounds could be found to fill these two gaps in the liquid set. Table II lists these liquids and their properties.

TABLE I

No.	Liquid	N_D			N_C			N_F		
		10°C	25°C	50°C	10°C	25°C	50°C	10°C	25°C	50°C
1	Methylene iodide	1.7474	1.7370	1.7205	1.7375	1.7273	1.7110	1.7744	1.7642	1.7474
2	α-iodonaphthalene	1.7060	1.6989	1.6874	1.6962	1.6893	1.6777	1.7340	1.7266	1.7142
3	α-bromonaphthalene + α-iodonaphthalene	1.6815	1.6747	1.6628	1.6720	1.6653	1.6535	1.7056	1.6991	1.6865
3a	*o*-bromoiodobenzene	1.6677	1.6600	1.6470	1.6600	1.6524	1.6396	1.6867	1.6785	1.6653
4	Phenylisothiocyanate	1.6555	1.6471	1.6330	1.6458	1.6374	1.6235	1.6817	1.6727	1.6585
5	Iodobenzene	1.6252	1.6163	1.6024	1.6179	1.6092	1.5955	1.6436	1.6339	1.6196
6	Bromoform	1.6029	1.5935	1.5790	1.5970	1.5882	1.5740	1.6159	1.6063	1.5915
7	*o*-toluidine	1.5768	1.5690	1.5565	1.5700	1.5630	1.5502	1.5934	1.5855	1.5724
8	*o*-nitrotoluene	1.5510	1.5435	1.5313	1.5440	1.5372	1.5252	1.5682	1.5600	1.5475
9	Propylene bromide	1.5240	1.5160	1.5024	1.5198	1.5120	1.4986	1.5330	1.5246	1.5113
10	Methyl furoate	1.4914	1.4850	1.4734	1.4859	1.4799	1.4686	1.5035	1.4965	1.4848
11	Methyl thiocyanate	1.4735	1.4659	1.4520	1.4693	1.4624	1.4489	1.4814	1.4735	1.4591
12	Trimethylene chloride	1.4535	1.4459	1.4338	1.4504	1.4424	1.4309	1.4586	1.4506	1.4387
13	Ethyl monochloroacetate	1.4265	1.4190	1.4071	1.4229	1.4168	1.4049	1.4309	1.4243	1.4116

TABLE II

	Liquids	N_D	Temperature (°C)
1	Methylene iodide	1.738	24
2	Methylene iodide + iodobenzene	1.715 (variable)	27
3	α-iodonaphthalene	1.697	27
4	α-iodonaphthalene + α-bromonaphthalene	1.677 (variable)	
5	*o*-bromoiodobenzene (or α-bromonaphthalene)	1.660	28
6	Phenylisothiocyanate	1.646	27
7	S-tetrabromoethane	1.6344	24
8	Iodobenzene	1.616	27
9	Bromoform	1.592	27
10	Anilin	1.581	24
11	*o*-toluidine	1.568	27
12	*o*-nitrobenzene	1.551	24
13	Ethylene bromide	1.536	24
14	Propylene bromide	1.515	27
15	Pentachloroethane	1.508	24
16	Methyl furoate	1.484	26
17	Methyl thiocyanate	1.4669	24
18	Isoamylsulfide	1.451	24
19	Ethyl dichloroacetate	1.435	24
20	Ethyl monochloroacetate	1.4200	24

The determination of high index minerals, without resorting to the tedious and time-consuming minimum deviation method, has been a difficult problem. The attempts to obtain immersion media with indices above 1.78 have resulted in compounds which are generally unsatisfactory in one way or another. Probably the greatest

objection is the fact that all of them are colored and some are nearly opaque, resulting in the absorption of considerable light and consequent inaccuracy of results. A partial list of high index media is given in Table III.

TABLE III

	Liquid		Refractive Index
1	Methylene iodide		1.738
2	" "	+ sulfur	to 1.79
3	" "	+ " + iodoform	to 1.81
4	Methylene iodide	+ " + iodoform + stannic iodide +	
	arsenic iodide	+ arsenic sulfide	to 1.85
5	Piperine	+ iodides	1.85–2.05
6	Selenium	+ sulfur[3] (yellow-orange to deep red color)	1.98–2.92

III. The Smithsonite Refractometer

For liquids of high index, the Abbé refractometer is unsatisfactory. As the liquids approach the glass prism in index, the distinction between the light and dark fields becomes less sharp and errors are of greater magnitude. Other unavoidable limitations of the high index Abbé are (1) the glass used in the prisms is yellow and absorbs the shorter light wave-lengths. All such high index glass is so colored. (2) The glass is very soft and loses its polish easily, thus impairing the accuracy of the instrument. (3) Most liquids in high index work are solutions of sulfur and various iodides in methylene iodide. Any free iodine in these liquids tends to combine with the lead of the glass prism and form a thin iodide film which renders the instrument inaccurate. (4) Further, this free iodine colors the liquid, resulting in considerable light absorption which makes the borders of the light and dark field very hazy and indefinite, with consequent inaccuracy of results.

With these limitations in mind, Dr. Emmons developed a high index refractometer by employing a mineral of high index and high birefringence, namely, smithsonite. This mineral varies in index of refraction from 1.70 to 1.86, depending on the direction of transmission of light through the crystal. The maximum variation occurs in plane polarized light, when the principal section of the smithsonite, which contains the greatest and least refractive indices, is parallel to the vibration of the light rays. Thus, by rotating such an oriented crystal through 90°, the refractive index can be made to vary from the lowest to the highest value and *vice versa*. In order that this rotation of the mineral could be secured, an elongate hole was cut in an ordinary microscope slide and a cover glass was cemented to one side with sodium silicate. On this cover glass, a cleavage fragment of smithsonite was cemented by one half, the other half being free of cement so that a portion of the mineral could be entirely immersed in an index liquid (see Fig. 1). The crystal is so oriented that the fragment rests on a cleavage face and the principal section is parallel with the length of the opening. The cavity is filled with liquid and covered with a cover glass. Too large a cavity is not desirable because of the amount of liquid necessary to fill it. The original one at the University of Wisconsin has a capacity of about eight drops. This liquid is recovered after use and the cavity washed with acetone or, if the liquid contains sulfur, with carbon disulfide. Two methods of calibrating the instrument are available, one theoretical, the other empirical. The first consists of determining the indices of the mineral by grinding a prism of the material and following the minimum deviation method outlined in standard text-books. For the empirical method, the mount is placed on a universal stage using high index hemispheres and a water cell for temperature control. The smithsonite is oriented with the principal section parallel to the polarizer of the microscope. Using two or three liquids of known index, such as α-iodonaphthalene (1.70), methylene iodide (1.74), and methylene iodide with sulfur and iodides (about 1.83), the positions of rotation on the outer horizontal (or *E–W*) axis of the universal stage, at which crystal and liquids agree for as many wave-lengths of light as curves are desired, are determined and plotted on a graph and curves drawn through the points. Once calibrated in this manner, the refractometer can be used to measure the index of any high liquid up to 1.86 by simply determining the amount of rotation

[3] H. E. Merwin and E. S. Larsen, "Mixtures of Amorphous Sulphur and Selenium as Immersion Media for the Determination of High Refractive Indices with the Microscope," *Amer. Jour. Sci.*, **34**, 42–47 (1912).

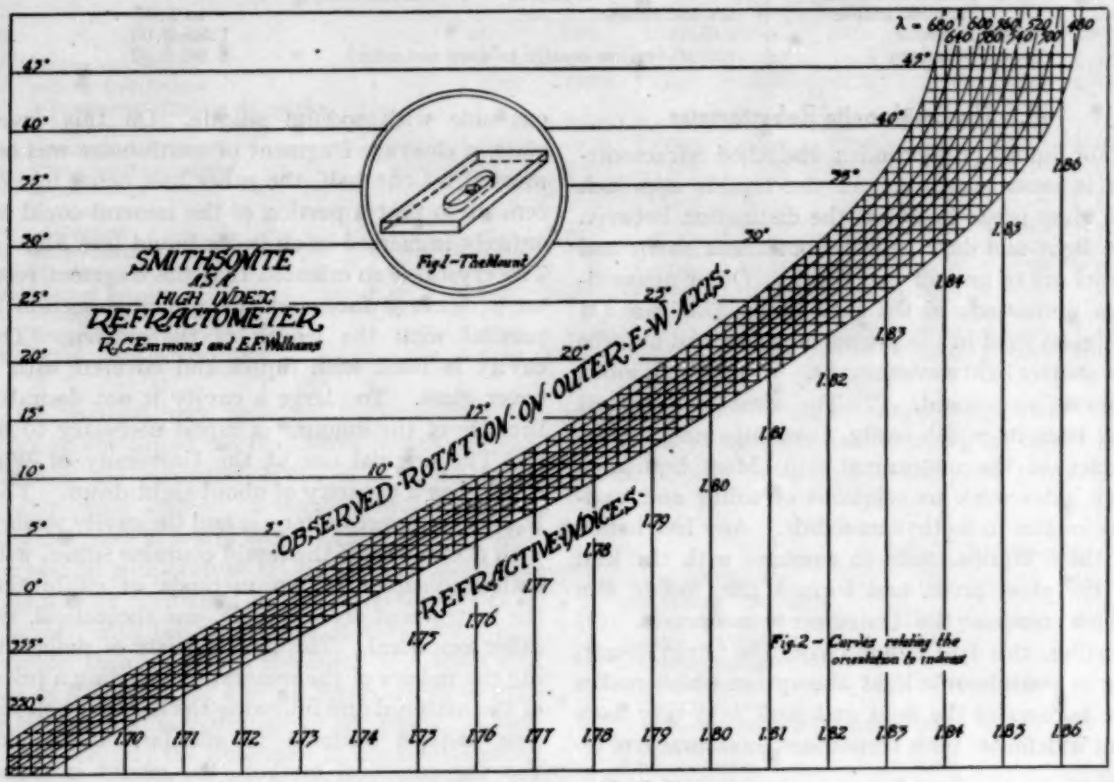
required to make the crystal agree with the liquid in index for any wave-length of light and reading the value directly from the graph (see Fig. 2).

IV. The Universal-Stage Birefringence Method of Determining High Index Minerals

The smithsonite refractometer is of considerable help in the determination of moderately high index minerals, but it still falls far short of solving the problem of a means for identification of the minerals in the highest index ranges. A lack of satisfactory immersion media above 1.86 led Dr. Emmons to attack the problem from the standpoint of birefringence.[3]

The method, in brief, is as follows: A grain is oriented to a standard orientation on the universal stage and then rotated to make an optic axis vertical. A quartz wedge compensating to the fourth order is inserted in the microscope. The grain is then rotated by means of one of the horizontal stage axes to complete compensation. The thickness of the grain is measured at the same time by ordinary microscope methods, using a few quartz grains as a standard to check. After routine corrections for hemisphere index have been made, the amount of rotation and the thickness of the grain are referred to a graph which establishes the birefringence of the mineral and, from this, its identification. The limit of error of this determinative procedure is about 0.005.

The application of this birefringence method of determining minerals of high refractive index is simpler and as accurate (if not more so) as the index-measuring procedure utilizing the unsatisfactory high index immersion media.



FIGS. 1 and 2.—Courtesy R. C. Emmons.

V. The Double-Variation Apparatus

The double-variation apparatus consists essentially of a petrographic microscope, a refractometer, a monochromator, an arc lamp, a water-circulating system with two matched thermometers, and a movable water cell which fits upon the microscope stage (Fig. 3). This cell consists of two glass windows, the lower one thick and the upper one thin, between which water flows, thus providing temperature control for the mount which is made in the usual way on the upper surface of the

[3] To be published.

cell. The light travels from the arc lamp through the monochromator to the microscope mirror, thence through the lower nicol, the lower window, a thin layer of water, and the upper window and mount to the objective. An adjustable mirror before the microscope permits the light to pass either through the refractometer or the microscope at the will of the operator. The water circulating in the system passes from the inlet valve past one thermometer to the water cell on the microscope stage, thence through an Abbé refractometer and past a second thermometer to the outlet.

repeated until a suitable number of determinations have been made. These results are plotted on a graph using refractive index as the ordinate scale and wave-length as the abscissa scale.

VI. The Universal Stage

A Leitz model of the Federow stage was modified by Dr. Emmons by the addition of one more horizontal axis of rotation, thereby simplifying the manipulation to a considerable extent although greatly complicating the manufacture of the instrument.[4]

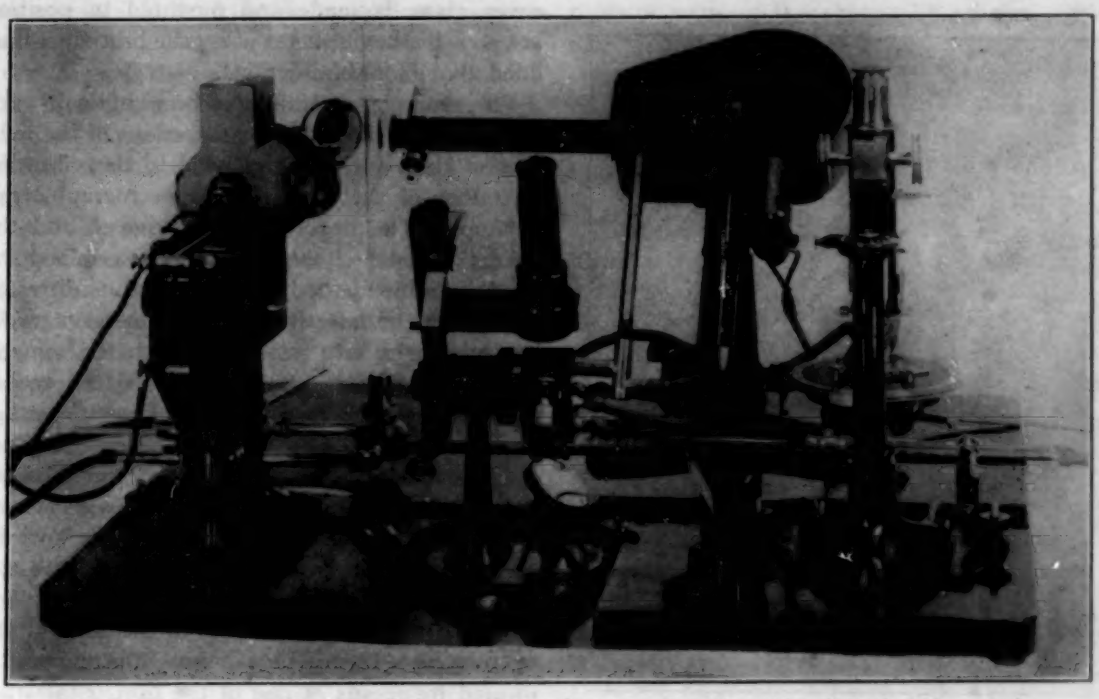


FIG. 3.—The Emmons double-variation apparatus (courtesy, Bausch and Lomb Optical Company).

The mineral to be studied is immersed in one of the "double-variation" liquids on the top surface of the water cell and covered with an ordinary cover glass. A drop of the same liquid is also placed on the refractometer. A suitable grain is selected for study and the index of mineral and liquid made to agree by variation of the wave-length of the monochromatic radiation. The index of the liquid is now obtained for light of this wave-length by means of the refractometer. The temperature of the liquid is then changed a few degrees by means of the water-circulating system, the liquid and mineral index are again matched by light wave-length change, and the refractometer reading is taken. This is

The advantages of the universal stage have been known to American petrographers for many years, but the instrument has seldom been used in this country because of (1) its complexity, involving a great deal of tedious and time-consuming manipulation, and (2) the lengthy graphical procedures necessary to an analysis of the observed results. The addition of the extra horizontal axis to the modified stage has greatly facilitated its operation and considerably reduced the amount of graphical computation. An experienced operator can make a complete study of the optical properties of a given mineral on the

[4] Such a modified universal stage is now sold by the Bausch and Lomb, Leitz, and Fuess optical companies.

Emmons stage in from one and one-half to three hours, depending upon the ability of the individual.

The next step was to adapt the universal stage to the double-variation apparatus. For this purpose, a water cell was developed to replace the central glass disk of the instrument to obtain temperature control of the mineral grain and the immersion liquid. The lower hemisphere of the universal stage was mounted in a metal disk. The central glass disk was cemented to a raised edge of the metal disk leaving a space between it

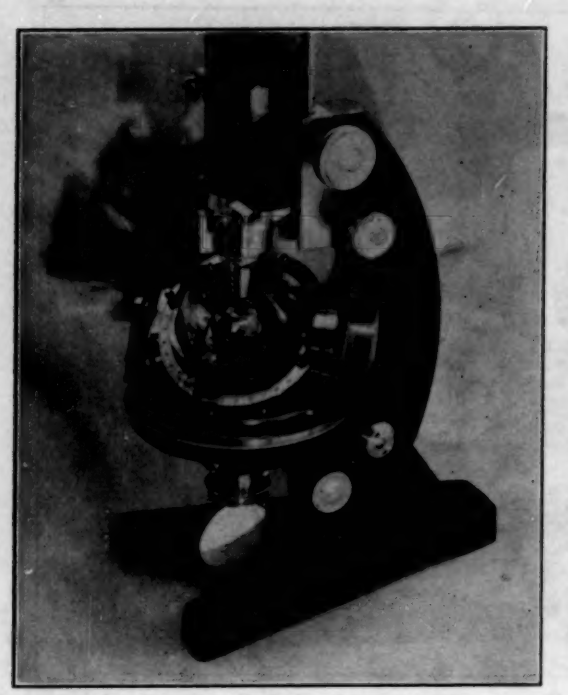


FIG. 4.—The Emmons modified universal stage (courtesy, Bausch and Lomb Optical Company).

and the top surface of the hemisphere, approximately the thickness of a microscope slide. Through this space, water of known temperature flows, directed by partitions to flow directly across the center of the cell and returning around the edges. The intake and outlet tubes are at one side in the metal disk on the lower surface of the cell. In mounting a mineral for study, no microscope slide is used, but a cover glass is placed on the glass disk of the cell, the powdered mineral on this, followed by another cover glass, and the whole covered by the upper hemisphere which is clamped into position, all of course with suitable liquid contacts. The immersion liquid to be used is determined by a cursory preliminary examination in the usual way and all contacts on the stage are made with the same liquid to avoid contamination.

The procedure for mounting thin sections differs to some extent. The water cell is removed and a drop of liquid is placed on the central glass disk and another on the cover glass of the thin section. The lower and upper hemispheres are then clamped into position with liquid contacts. If a powder mount is desired without the water cell, a standard mount, using a microscope slide and cover glass, is made and mounted in position between the hemispheres using the procedure outlined above for thin sections.

For example, a grain has been optically oriented so that the vibration directions of the light rays of the mineral are parallel to the vibration directions of the nicols of the petrographic microscope. The upper nicol is removed and the refractive index of the mineral is determined (by the Becke-line method) for the vibration direction parallel to the lower nicol, the immersion media being brought into agreement with the mineral by variation of the wave-length of the monochromatic illumination. The microscope stage is then rotated ninety degrees, bringing another ray into a position parallel to the lower nicol vibration direction and the index for this ray measured. If the grain is uniaxial with only two directions of vibration, these two measurements may suffice. It is possible, however, that the second vibration direction is parallel to the tube of the microscope. If this be the case, the mineral is rotated by means of one of the horizontal stage axes through ninety degrees to bring it parallel to the vibration direction of the lower nicol, in which position the index is measured. More often than not, the grain can not be rotated through ninety degrees on one of the horizontal axes. When this occurs, the greatest rotation possible is made, the index read for this rotation, and the true index extrapolated by graphical means, the extrapolation consuming only a few minutes.

With biaxial crystals, having three vibration directions, the two in the plane of the microscope stage are measured by the ninety-degree rotation of the stage. The third ray is parallel to the tube of the microscope and is rotated into parallelism or partial parallelism with the lower nicol by means of one of the horizontal stage axes. If a

ninety-degree rotation is not possible, extrapolation must be employed to obtain a true value for this ray. Every time the mineral and liquid indices are matched for a given temperature by variation of light wave-length, the refractive index of the liquid is determined from the refractometer. After a reading for each ray has been obtained, the temperature of the water system is changed three to five degrees and a new set of index readings for the three rays is obtained. Three such determinations for each ray are usually sufficient and can be plotted upon a graph sheet. Grains of high birefringence sometimes require two separate mounts using different liquids in order to reach the index extremes of the mineral. This is necessary because of the limited index range of the immersion media at the maximum suitable variation of temperature and wave-length.

VII. Conclusion

The character of the raw materials is of prime importance to the manufacturer. The detailed mineral content and mineral relationships determine not only the properties of the product but its process of manufacture as well. New sources of supply require further mineralogical work of the type described here. Chemical analyses express the composition of the deposits as percentages of the oxides of the various bases but tell nothing of the physical form in which these oxides occur. It is to problems of this sort that the petrographic microscope is especially adapted.

It has been found that small changes of chemical composition within a mineral substance or a glass considerably affects its refractive index. This is especially true when indices can be measured accurately to the fourth decimal place. These changes can be discovered readily with the double-variation method and in less time than would be required for a chemical analysis. From an accurate determination of the refractive indices of some of the chemically simpler isomorphous minerals, the percentage composition of the component oxides can be obtained without resorting to chemical methods. This means of chemical analysis fails with the more complex minerals mainly because of the lack of sufficient optical data on chemically analyzed materials.

In the comparatively recent literature, numerous illustrations of the application of the petrographic microscope to problems of raw material and to problems of the manufactured product may be found. The purpose of the double-variation procedure is to render the solution of such problems by the petrographic method more rapid and more accurate.

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EFFECT OF A TREMOLITIC TALC IN WHITEWARE BODIES*

By Donald Hagar

Abstract

This paper describes the use of a specific type of talc in wall-tile bodies and explains the effect of various percentages on shrinkage, absorption, modulus of rupture, moisture expansion, and resistance to delayed crazing. The data indicate the effects of talc with various combinations of wall-tile body ingredients and the compositions and heat treatment of greatest potential resistance to crazing.

I. Introduction

Crazing of wall tile shortly after being placed in the wall has hindered the use of this product as a building material. Vitreous and semivitreous tile have found a limited market, but the major demand has been for the more porous wall tile and, until recently, these have not been sufficiently resistant to crazing. Tremolitic talc, as an ingredient of porous tile bodies, has decidedly improved their crazing resistance.

II. Experimental

(1) Bodies

Series 1 (Table I) shows the effect of varying percentages of the talc on a combination of ball and Florida clays; series 2, the effect on the clays combined with feldspars; series 3, the effect on the clays combined with flint; and series 4, the effect on the clays combined with pyrophyllite.

(2) Methods

The mixtures, in slip form, were screened through a 120-mesh sieve, dried, tempered with 11% of water, and then disintegrated through a 14-mesh sieve. The test pieces were pressed on a mechanical press by an experienced operator and were of a size which, with normal tile shrinkage, would produce a piece $4^1/_4$ by $2^1/_8$ by $^3/_8$ inch. The pieces were fired at cones 1, 6, and 10 in a downdraft periodic kiln.

One piece each of the bisque bodies was glazed with a transparent tile glaze maturing at cone 1. The visual effect of the "fit" of this glaze and the

Table I

Formulas of Bodies

Series 1	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j
Ball clay	42.0	37.8	33.6	29.4	25.2	21.0	16.8	12.6	8.4	4.2
Fla. kaolin	58.0	52.2	46.4	40.6	34.8	29.0	23.2	17.4	11.6	5.8
Tremolitic talc		10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0

Series 2	2a	2c	2e	2g	2i
Ball clay	36.9	29.5	22.1	14.8	7.4
Fla. kaolin	50.8	40.7	30.5	20.3	10.1
Feldspar	12.3	9.8	7.4	4.9	2.5
Tremolitic talc		20.0	40.0	60.0	80.0

Series 3	3a	3c	3e	3g	3i
Ball clay	26.1	20.9	15.7	10.4	5.2
Fla. kaolin	35.9	28.7	21.5	14.4	7.2
Flint	38.0	30.4	22.8	15.2	7.6
Tremolitic talc		20.0	40.0	60.0	80.0

Series 4	4a	4c	4e	4g	4i
Ball clay	26.1	20.9	15.7	10.4	5.2
Fla. kaolin	35.9	28.7	21.5	14.4	7.2
Pyrophyllite	38.0	30.4	22.8	15.2	7.6
Tremolitic talc		20.0	40.0	60.0	80.0

The talc has been used in two ways, *viz.*, (1) percentage amounts above 50 with no feldspar and (2) percentage amounts under 10 with small amounts of feldspar.

The talc used in this study was obtained from St. Lawrence County, N. Y., and is the product of alteration of tremolite, a member of the amphibole group of minerals.

* Presented at the Annual Meeting, American Ceramic Society, Buffalo, N. Y., February, 1935 (White Wares Division). Received July 9, 1935.

color of the bodies were observed and recorded. Several additional pieces of each body were glazed with a semimat glaze. It was necessary to use this type of glaze to prevent absorption of the glaze by those bodies high in talc content.

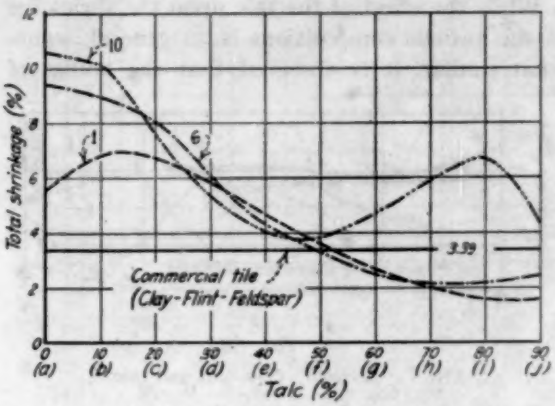

FIG. 1.—Series 1: clay and talc.

These semimat-glazed specimens were used for the warpage determinations and the autoclave-crazing and quench-crazing tests.

Water absorption was determined in accordance with the recommendations of the Standards Committee of the American Ceramic Society, and the absorption was expressed as a percentage

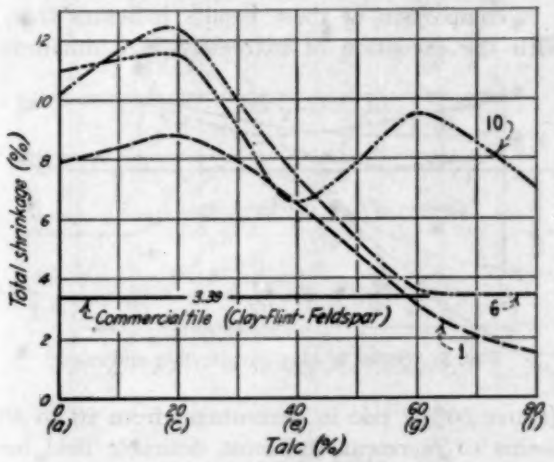

FIG. 2.—Series 2: clay-feldspar and talc.

of the weight of the dry piece. Modulus of rupture data were obtained on an apparatus especially designed for the shape of the specimens used.

The moisture expansion of the bodies after a one-hour autoclave treatment at 150 pounds steam pressure was measured by means of a micrometer graduated to read in ten thousandths of an inch and mounted rigidly on a frame equipped with a saddle to hold the specimens in the same relative position at all times. The specimens were dried at 115°C ±5°C, measured, autoclaved as described, and again measured

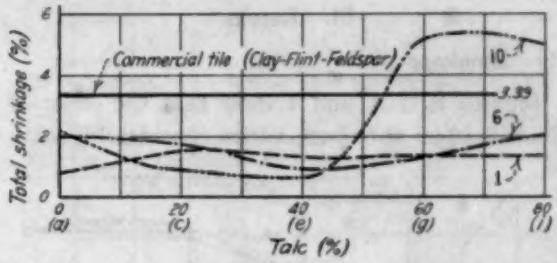

FIG. 3.—Series 3: clay-flint and talc.

after autoclaving. The moisture expansion was expressed as a percentage of the original length of the piece.

The fired length of the specimens was taken from the micrometer readings of the moisture-expansion determinations. Linear shrinkage was expressed as a percentage of the length of the die used.

"Glaze warpage," the type of warpage caused in the glost fire, was considered to have an important bearing on "glaze fit." For this deter-

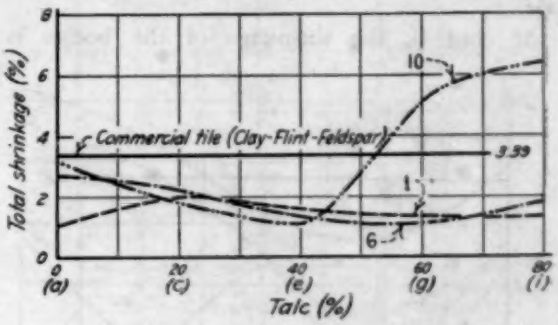

FIG. 4.—Series 4: clay-pyrophyllite and talc.

mination, the specimens were measured before and after the glost fire on an apparatus consisting of a frame to hold the pieces in position and equipped with a dial indicator mounted to the frame. The degree of warpage was measured at the center of a $3^1/_2$-inch length of the specimens and the data given are the direct readings of the indicator.

The autoclave-crazing test consisted of five successive treatments at 150 pounds steam pressure for one hour.

The quench test consisted of heating the specimens to 100°C above room temperature and quenching in water at room temperature. Five successive quenchings constituted the completed test.

III. Results

(1) Shrinkage

Figures 1, 2, 3, and 4 show that the effect of the talc upon shrinkage varies considerably with

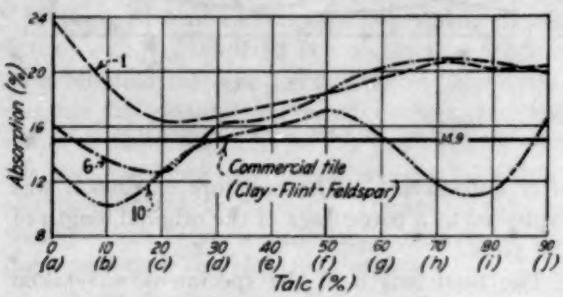

FIG. 5.—Series 1: clay and talc.

the firing temperature as well as with the body compositions.

At cone 1, talc in amounts up to 20% increase shrinkage slightly, whereas talc additions above 20% steadily decrease shrinkage, the lowest values being obtained at approximately 80% talc.

At cone 6, the shrinkage of the bodies is

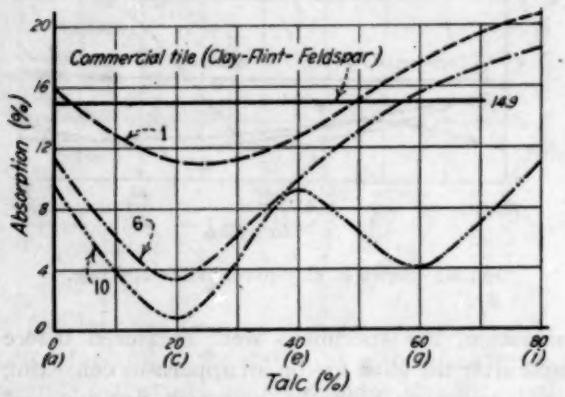

FIG. 6.—Series 2: clay-feldspar and talc.

slightly decreased by talc amounts up to 20% and as the talc content is further increased a rapid but uniform decrease in shrinkage is evident. This characteristic holds true in all cases except series 2 (clay-feldspar-talc), where the effect of talc additions is similar to that obtained at cone 1.

The shrinkages at cone 10 are considerably different from those obtained at cones 1 and 6, in that shrinkage rapidly decreases with progressive additions of talc up to 50% and then immediately begins to increase sharply as the talc content is increased above 50%.

While the effect of the talc upon the shrinkage of the various compositions is, in general, somewhat similar, it is observed that the bodies of

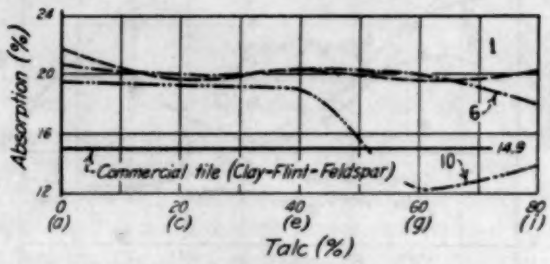

FIG. 7.—Series 3: clay-flint and talc.

series 2, containing feldspar, not only have higher shrinkages but are also more susceptible to variations in temperature.

Both flint and pyrophyllite decrease the shrinkage. In series 3, containing flint, the cone 6 bodies of lowest shrinkage are obtained at 40% talc as compared with 60% talc for the pyrophyllite series and 70% talc for series 1 containing all clay.

A comparison of these results indicates that, with the exception of extremely high amounts

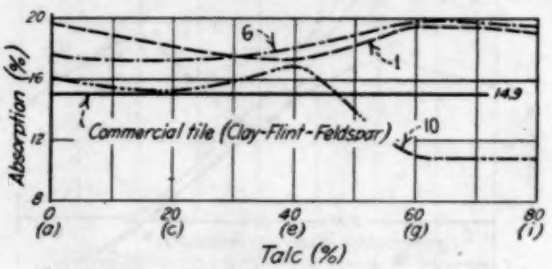

FIG. 8.—Series 4: clay-pyrophyllite and talc.

(above 50%), talc in percentages from 20 to 40 seems to represent the most desirable field for producing low-shrinkage bodies.

(2) Absorption

The effect of the talc upon the absorption is similar to the effect upon shrinkage (Figs. 5, 6, 7, and 8). In all cases, bodies of high shrinkage are those of low absorption and *vice versa*. In general, it may be said that in compositions including clay-talc and clay-feldspar-talc, addi-

tions of talc from 10 to 20% have an active fluxing action. This fluxing action decreases as the talc content is increased up to 80% talc at cones 1 and 6 and up to 40 to 50% at cone 10.

Talc additions from 10 to 40% have very little fluxing action on mixtures containing comparatively high amounts of flint and pyrophyllite; those containing the flint are the most porous, averaging about 3.3% more than the corresponding pyrophyllite bodies. The higher porosity of the flint bodies may account in part for the extreme regularity of the absorption curves for the series 3 bodies containing from 10 to 40% talc. The results indicate that flint has a desirable stabilizing influence on absorption.

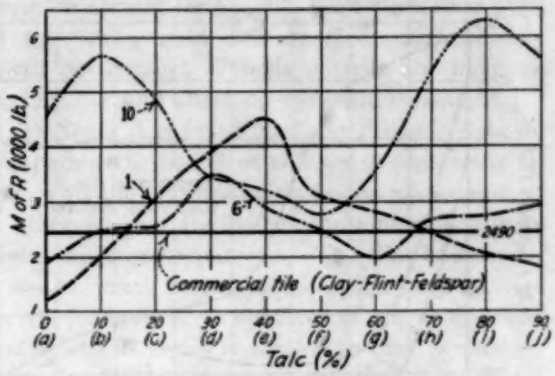

FIG. 9.—Series 1: clay and talc.

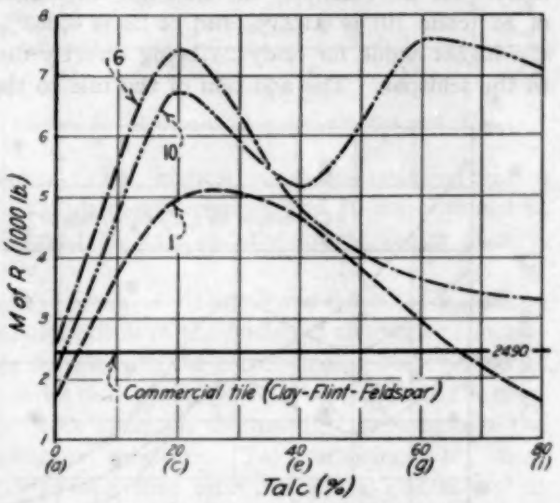

FIG. 10.—Series 2: clay-feldspar and talc.

As in the case of shrinkage, talc in percentages from 20 to 40 appears to represent the most desirable range for the production of bodies of uniform absorption.

(3) Modulus of Rupture

Some of the specimens of bodies 1*a*, 2*a*, 1*b*, and 1*c* (Figs. 9, 10, 11, and 12), selected for this determination, showed evidences of fire-cracking after breaking. Consequently, the data on these bodies can not be accepted as strictly comparative.

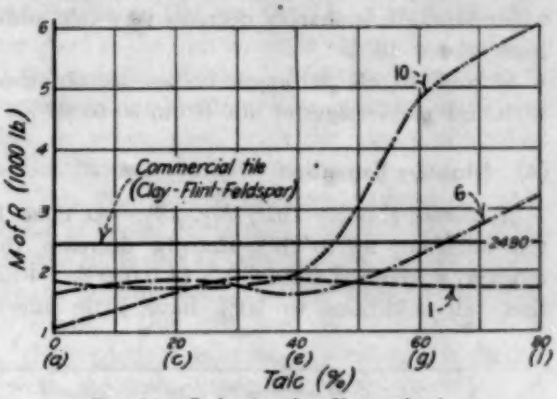

FIG. 11.—Series 3: clay-flint and talc.

In the clay and clay-feldspar combinations (series 1 and 2; cones 1 and 6), talc additions from 10 to 40% produce a marked increase in the strength of the bodies. In these bodies the relationship of low absorption-high strength holds generally true. There are certain exceptions,

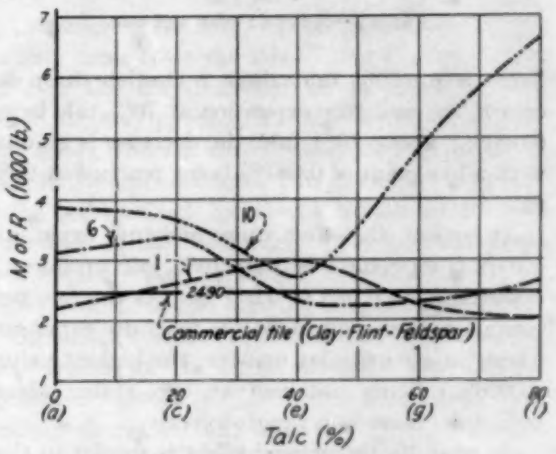

FIG. 12.—Series 4: clay-pyrophyllite and talc.

such as body 1*e* which, however, has the highest strength of any cone 1 body in the series, yet does not have the lowest absorption.

Talc additions from 10 to 40% have only a slight effect upon the clay-flint and clay-pyrophyllite mixtures of series 3 and 4. This effect is more pronounced in the clay-pyrophyllite combinations than in the clay-flint combinations.

This may be due to the more porous nature of the clay-flint bodies.

Increases of the talc above 40% at cones 1 and 6 do not materially affect the strength of the bodies except in the clay-feldspar compositions where strength is sharply decreased by talc additions above 40%.

At cone 10, the strongest bodies are obtained with high percentages of talc (from 60 to 80%).

(4) Moisture Expansion

(*a*) *Series 1* (*Clay-Talc, Fig. 13*).—At cone 1, talc additions up to 20% sharply decrease the moisture expansion from 0.048 to 0.029%. Further talc additions to 50% have little effect.

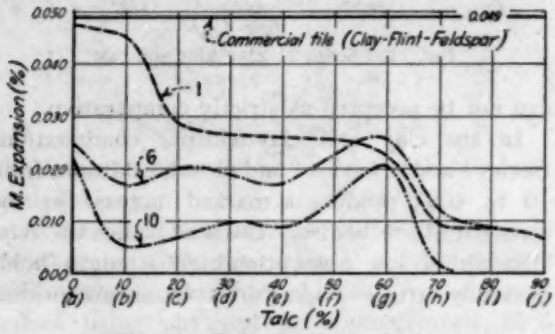

FIG. 13.—Series 1: clay and talc.

From 50 to 70% talc, there is another sharp decrease, the moisture expansion at 70% talc being 0.009%; above 70% talc, the decrease is gradual with a low point of 0.007% being reached at 90% talc.

At cone 6, the effect upon moisture expansion differs from cone 1 in that 10% talc produces a decrease from 0.025 to 0.017%. As the talc percentage is increased to 60, the moisture expansion varies in an irregular manner, the highest values (0.026%) being obtained at 60% talc; above 60% talc, there is a rapid decrease.

At cone 10, the general effect is similar to that obtained at cone 6 except that the cone 10 values are lower; 10% talc reduces moisture expansion from 0.023 to 0.005%. Between 10 and 60% talc, there is the same irregular increase in moisture expansion as noted at cone 6, and again the highest value (0.021) is obtained at 60% talc. As the talc content is further increased, there is a sharp decrease in expansion until at 80% talc no measurable value is obtained. It is of more than usual interest to note that 10% of talc at cone 10 produces a body of lower moisture expansion than any of the higher percentages below 70% talc.

(*b*) *Series 2* (*Clay-Feldspar-Talc, Fig. 14*).—By comparing the bodies of this series, which contain

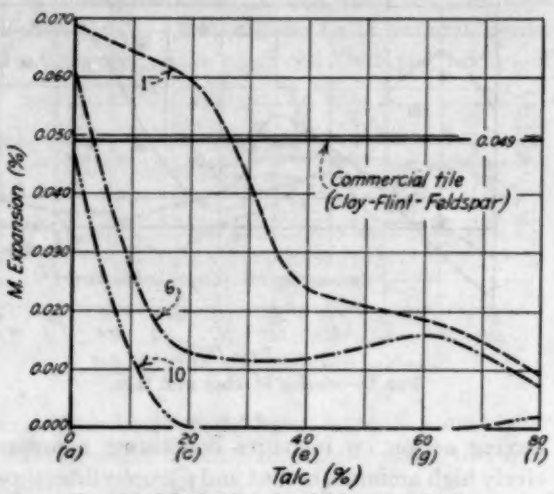

FIG. 14.—Series 2: clay-feldspar and talc.

no talc, with those of series 1, which contain no talc, it will be seen that the addition of feldspar greatly increases the moisture expansion of a given body. As an example, the moisture expansion of 1*a* (cone 10) is 0.023% and of 2*a* is 0.063%, the higher value for body 2*a* being directly due to the feldspar. The addition of the talc to the

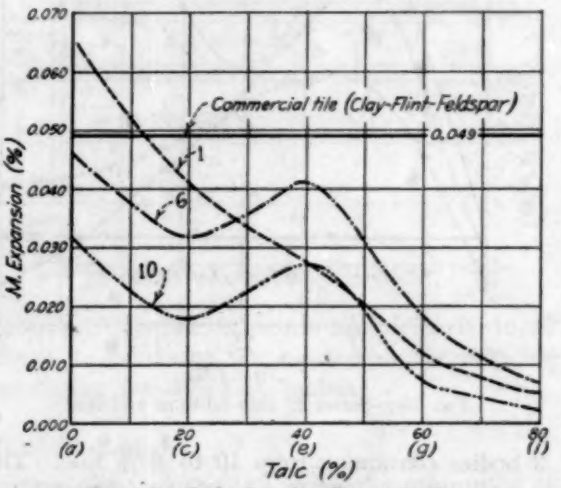

FIG. 15.—Series 3: clay-flint and talc.

clay-feldspar mixtures brings about a rapid decrease in moisture expansion, the effect being similar to that of series 1. The extremely low values of the cone 10 bodies of this series are no

doubt due to the low absorption of these bodies.

A comparison of bodies 2*e* and 2*g*, matured at cones 1 and 6, with the corresponding bodies (1*e* and 1g) of series 1, will show that the moisture-expansion values for these bodies of higher absorption are not far apart. Used with 40 to 60% of talc, this would indicate that comparatively small percentages of feldspar will not have an unduly harmful effect on moisture expansion.

(*c*) *Series 3* (*Clay-Flint-Talc, Fig. 15*).—Again comparing the bodies of this series containing no talc with the corresponding bodies of series 1, it is observed that the bodies containing flint have higher moisture expansion. The flint bodies are, however, much more porous, which may account for the difference. The effect of the talc on the bodies of this series is similar to that of series 1 except that the moisture-expansion values are

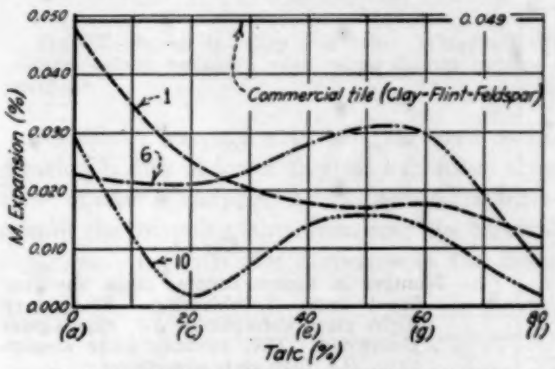

FIG. 16.—Series 4: clay-pyrophyllite and talc.

higher. The highest moisture-expansion values for talc bodies at cones 6 and 10 are obtained at 40 and 60% talc and the lowest values at 80% talc.

(*d*) *Series 4* (*Clay-Pyrophyllite, Fig. 16*).—A comparison of the bodies of this series containing no talc with the corresponding bodies of series 1 shows that pyrophyllite, when added to the clay, has little effect on the moisture expansion of the resultant mixtures. Talc additions to these clay-pyrophyllite mixtures cause a decrease in the moisture expansion, the effect being similar to that of series 3, but the values of the clay-pyrophyllite bodies are lower. It is of especial interest to note that 20% of talc at cone 10 in body 4*c* produces the extremely low moisture expansion of 0.002%. This is of particular importance as it indicates that bodies of very low moisture expansion can be produced by the use of the lower talc percentages.

Of the four series of bodies studied, the clay and clay-pyrophyllite mixtures have the lowest moisture expansions. Feldspar and flint both increase the moisture expansion of mixtures in which they are included, with the effect of the feldspar being the greater. It is probable that the effect of the flint is due to the greater porosity of the resultant bodies. Addition of the talc to these four combinations lowers moisture expansion in every case, with the clay-pyrophyllite bodies having the lowest values.

While the lowest moisture expansions were shown in bodies containing high talc (70 to 80%) at cone 10, bodies of very low moisture expansion can be produced at cone 10, using from 10 to 20% talc. This can best be accomplished in clay-pyrophyllite mixtures. Although bodies of lowest moisture expansion were produced at cone 10, all of the bodies produced at cones 1 and 6 have much lower expansions than the commercial wall tile. It is believed that this low temperature field has certain factors in its favor and the possibility of developing both one- and two-fire bodies at these temperatures (cones 1 and 6) should not be overlooked.

(5) "Glaze Fit"[1]

Considering the effect of the glaze on the bodies as they come from the kiln (Table II), the "glaze fit" on the clay-flint-talc series appears best, with the clay-pyrophyllite-talc series, the clay-talc series, and the clay-feldspar-talc series being next in the order named. The glaze fit is better on those bodies which received a bisque fire of cone 1 as none of the bodies fired to this temperature was crazed. As the bisque fire is increased to cones 6 and 10, the amount of crazing increases.

On bodies matured at cones 6 and 10, it is noted that crazing of the glaze increases with the increase in talc to 40%. Above 40% talc, this crazing decreases, and above 60% talc, it disappears altogether.[2] This would seem to indicate that the bodies under consideration have undergone a change in thermal expansion, *i.e.*, thermal expansion of the bodies being first decreased and then increased by progressive additions of talc. The evidence that crazing becomes more pronounced as the bisque maturing tempera-

[1] As indicated by the visual effect of a transparent glaze on the various bodies studied.

[2] This has been clearly shown by R. F. Geller and A. S. Creamer, "Lime-Free and Lime-Bearing Talc in Whiteware," *Jour. Amer. Ceram. Soc.*, 18 [9] 259–69 (1935).

ture is increased would likewise indicate that the thermal expansion of talc bodies decreases as the firing temperature is increased.[2]

The tendency of the usual tile glaze to craze on those bodies fired at cones 6 and 10 and containing under 60% talc means that (1) a new type of glaze must be developed to fit these bodies, (2) the bodies must be matured below cone 6, or (3) it will be necessary to use bodies containing 60% or above of talc.

Talc bodies tend to absorb the glazes placed on them and, under certain conditions, this characteristic is so pronounced as to cause the glaze to disappear entirely. The tendency of the body to absorb the glaze increases with the talc content as well as with the maturing temperature. This effect becomes very evident at 40% talc on those bodies matured at cones 6 and 10 and at 50% talc in the bodies matured at cone 1. To overcome glaze absorption, it is necessary to (1) keep the talc content of the bodies below 50% or (2) develop new glazes which can be applied heavier and which will not be so readily absorbed.

TABLE II

"GLAZE FIT" CHART

(As indicated by the visual effect of a transparent glaze on the various bodies studied.)

	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j
Cone 10		9	13	14	*HA* 14	*HA* 8	*HA* 6	*HA*	*HA*	*HA*
Cone 6	2		4	16	*VSA* 30	*SA* 16	*MA* 4	*HA*	*HA*	*HA*
Cone 1	13					*VSA*	*MA*	*MA*	*HA*	*HA*

	2a	2c	2e	2g	2i
Cone 10	12	16	*VSA* 16	*HA* 8	*HA*
Cone 6	10	8	32	*HA* 5	*HA*
Cone 1	16	2		*MA*	*HA*

	3a	3c	3e	3g	3i
Cone 10	*S*	3	*HA*	*HA*	*HA*
Cone 6			*SA*	*MA*	*HA*
Cone 1	4		*SA*	*MA*	*HA*

	4a	4c	4e	4g	4i
Cone 10		7	*HA* 4	*HA*	*HA*
Cone 6	1		9	*HA* 2	*HA*
Cone 1	32			*MA*	*HA*

Key

Number in square denotes craze lines per lineal inch: *S*, shivering; *VSA*, very slight glaze absorption; *SA*, slight glaze absorption; *MA*, medium glaze absorption; *HA*, high glaze absorption.

(6) "Glaze Warpage"

The data (Figs. 17, 18, 19, and 20) show an interesting relationship between the maturing temperature of the body and the degree and type of the warpage as well as a relationship between the body compositions and warpage. These relationships closely correspond to those described

under "glaze fit" and seem to confirm the results therein noted. The numerical values of the warpage data provide a clearer conception of these effects. The warpage is both concave and convex and, in general, the higher the bisque temperatures of a given series of talc bodies the greater the concave warpage. As the bisque temperature is decreased, the warpage changes from the concave toward the convex.

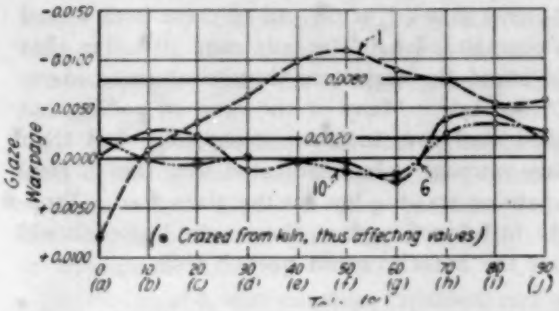

FIG. 17.—Series 1: Clay and talc. Minus values express convex warpage; plus values express concave warpage.

If concave warpage may be considered as indicating bodies of lower thermal expansion than those of convex warpage, it represents a confirmation of the foregoing statement, *viz.*, "the thermal expansion of talc bodies decreases as the firing

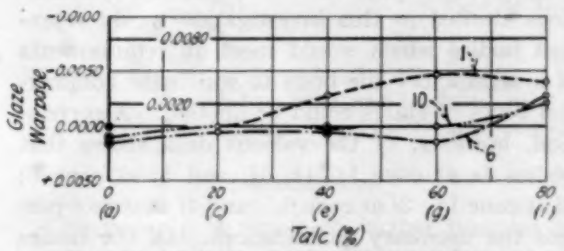

FIG. 18.—Series 2: Clay-feldspar and talc.

temperature increases." Again referring to the data, the reverse appears to hold true in those bodies which contain no talc.

The effects of the various body compositions on the warpage of the clay and clay-pyrophyllite bodies are similar. Bodies containing flint have higher convex warpage and bodies containing feldspar show more concave warpage. This likewise corresponds with previous conclusions reached.

The tendency of bodies of high talc content (60% and above), matured at cones 6 and 10, to show convex warpage is further indication that

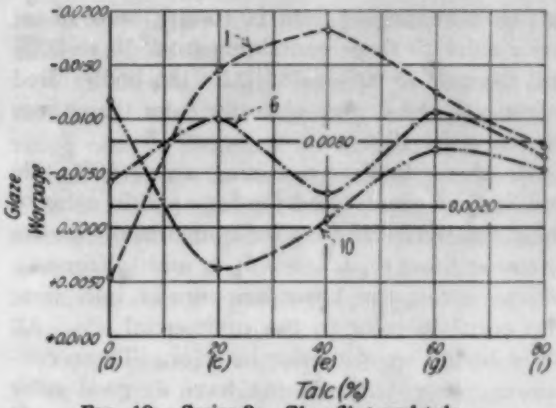

FIG. 19.—Series 3: Clay-flint and talc.

thermal expansion is increased as the talc content exceeds 60%.

In practice, it is deemed advisable to hold the glaze under compression as much as possible. The average warpage on the $3^1/_2$-inch length of the commercial tile tested was convex to the extent of 0.008 inch. This is considered the maximum allowable convex warpage for the commercial body without causing shivering of the glaze or a high percentage of rejects.

The results of the quenching tests (Part II (9)) show that all bodies which withstood five quenchings have a convex warpage of not less than 0.002 inch. All bodies of concave warpage or lower convex warpage than 0.002 inch either crazed when withdrawn from the kiln or failed in the quench test. It is believed that talc bodies, falling within the limits of convex warpage described (*i.e.* from 0.002 to 0.008 inch), can be successfully used with the present types of tile glazes. The measurement of warpage is suggesed as a quick method for indicating glaze fit.

(7) Color

Considering the color of the bodies included in this study, it was found that those having a

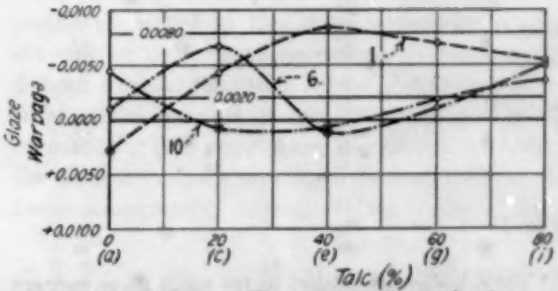

FIG. 20.—Series 4: Clay-pyrophyllite and talc.

talc content ranging from 20 to 40% were of inferior color to those containing from 10 to 20% and from 60 to 90% talc. Also the bodies fired at cones 1 and 6 were of better color than those fired at cone 10.

All of the bodies containing above 60% talc and fired at cones 1 and 6 were equal in color to the commercial tile used for comparison. Bodies 3*c* (cones 1 and 6), 4*c* (cone 6), 1*c* and 1*d* (cone 1), which contain the lower amounts of talc, were also equal in color to the commercial tile. All other bodies were inferior in color. Those containing pyrophyllite do not have as good color as the mixtures containing equal amounts of flint.

The talc itself is extremely white in both the raw and calcined states, but when combined with clays containing iron compounds as impurities, the resultant fired mixtures are discolored to a cream or even yellowish shade, the extent of the discoloration depending on the amount of iron present. To produce talc bodies of good color, the ball and china clays should be of the best color attainable. The ball-clay content should be kept as low as possible.

(8) Autoclave-Crazing Test

Of the 25 bodies studied, 18 withstood five autoclave treatments with no sign of crazing (Table III). By comparison, the commercial tile tested failed badly during the first treatment.

TABLE III

BODIES WHICH WITHSTOOD FIVE AUTOCLAVE TREATMENTS

Series No.	Firing Temperature		
	Cone 1	Cone 6	Cone 10
Series I	1*d*		
	1*e**		
	1*f**		
	1*g**		
	1*h*	1*h*	1*h*
	1*i*	1*i*	1*i*
	1*j*	1*j*	1*j*
Series II	2*e*		
	2*g*		
	2*i*	2*i*	2*i*
Series III	3*c**	3*c**	
	3*e**		
	3*g**	3*g**	3*g*
	3*i*	3*i*	3*i*
		4*c*	
Series IV	4*e*		
	4*g*		
	4*i*	4*i*	4*i*

* These bodies are subject to too much glaze warpage to be commercially practicable.

The moisture-expansion values of bodies that passed the test varied from 0.002 to 0.046%. All bodies, however, with moisture-expansion values within this range did not stand the test. Inasmuch as these either crazed directly from the kiln or failed during quenching, it is thought their failure in the autoclave may have been due to thermal shock.

The bodies of 20 to 40% talc content that withstood the autoclave treatment were those fired at either cones 1 or 6. All of these bodies fired at cone 10 failed. The only cone 10 bodies that did stand the test were those containing above 50% of talc. Many of the cone 10 bodies that failed had low moisture expansions, but their glaze-warpage values indicated that the thermal expansion was too low for the glaze used. Properly fitted with a glaze, these same bodies should pass the autoclave and quench tests.

(9) Quench Test

Eighteen of the twenty-five bodies successfully passed the quench test. These were the identical bodies that withstood the autoclave treatments (Table III).

IV. Discussion

It was not expected that many of the combinations studied in this investigation would represent bodies which would meet all requirements of a satisfactory tile body to which the commercial types of glazes could be applied. A correlation, however, of the various data shows that bodies 4*e* at cone 1; 1*h*, 1*i*, and 1*j* at cone 6; 2*i* at cone 1; 3*i* at cone 6; and 4*i* at cone 6 possess the necessary qualifications. Of the bodies named, 4*e* is the only one containing less than 50% talc. All of others contain from 60 to 90%. It will also be noted that the satisfactory bodies are those which have been fired at cones 1 and 6.

While body 4*e* is the only one containing less than 50% talc, there are several others in series 3 and 4 which contain the intermediate talc percentages (20 to 40%) and which are satisfactory except for slightly high absorption and glaze warpage. The use of small percentages of feldspar or some other flux should correct these deficiencies.

Certain of the bodies fired at cone 10 and containing from 20 to 40% talc meet all requirements but do not fit the tile glazes. To successfully pro-

duce bodies at cone 10 using these percentages of talc, it will be necessary to develop glazes of lower thermal expansion.

V. Conclusions

(1) Wall-tile bodies of low moisture expansion and high resistance to delayed crazing can be developed by the use of tremolitic talc in conjunction with the other materials studied. Such bodies have (1) less shrinkage, (2) greater transverse strength, and (3) much higher resistance to delayed crazing than the commercial clay-flint-feldspar bodies in use.

(2) Clay, pyrophyllite, and flint represent the most desirable materials to use in the formation of these bodies. Under certain conditions, however, the use of limited quantities of feldspar may be advantageous.

(3) Bodies of lowest moisture expansion can be developed at cone 10, using both intermediate (20 to 40) and high (above 60) percentages of the talc. Bodies matured at this temperature, however, require the development of special glazes to fit them.

(4) Bodies of high crazing resistance, low shrinkage, adequate strength, and long firing range can be produced at cones 1 and 6. Although these bodies do not have moisture expansions as low as those matured at cone 10, they are attendant with less difficulty in their adaptation to commercial operation and are materially better in crazing resistance than the commercial wall tile in use.

(5) In general, bodies of high talc content (above 50%) are better than those containing the intermediate talc percentages (20 to 40). Bodies containing the intermediate amounts are also highly resistant to crazing and are less susceptible to production difficulties.

(6) The effect of the talc in lowering the maturing point of the body permits of possible fuel savings by utilizing lower operating temperatures.

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RAW LEADLESS GLAZES FOR POTTERY AND TILE AT CONE 2*

By C. W. Merritt

Abstract

A base glaze was developed, using colemanite as the principal flux. A series of colors was produced by blending ten glazes containing different coloring materials.

I. Introduction

This paper is a report of further progress in the use of colemanite as the essential flux in low-temperature glazes. The fact that colemanite is a hydrated calcium-borate mineral, which is insoluble in water and fuses to a clear glass at a temperature of about 900°C, makes it valuable as a glaze ingredient. Some of the effects, however, which are produced in raw lead and fritted glazes can not be duplicated in these lead-free glazes, but it is not necessary to apologize for the colors that can be produced in these colemanite glazes. In many cases, they are quite different and present a pleasant contrast.

The glazes developed in this work are intended for wall tile and for pottery which can be fired at about cone 2.

II. Procedure

(1) Base Glaze

The materials used with the colemanite in compounding these glazes are those which are ordinarily found in the glaze laboratory. The amount of colemanite necessary to produce the desired fusibility is much less in this cone 2 series than in the cone 04 glazes that were previously reported.[1] The same basic oxides are used with the CaO from the colemanite as were used in the lower-temperature series, namely, ZnO, K_2O,

* Presented at the Annual Meeting, American Ceramic Society, Buffalo, N. Y., February, 1935 (Art Division).

[1] C. W. Merritt, "A Series of Raw Leadless Glazes at Low Temperatures," *Bull. Amer. Ceram. Soc.*, **14** [3] 104–106 (1935).

and BaO, and with one addition, that of MgO. This oxide is made available, due to the increased temperature, and was introduced into the glaze batch in the form of steatite. When magnesium carbonate was used as the source of MgO, the glaze showed a tendency to crack and crawl. The same was true in the glazes high in ZnO, and the trouble was remedied in this case by using calcined zinc oxide.

Since colemanite acts as a deflocculating agent, it was found desirable to counteract this condition by the addition of some substance which would not be harmful to the glaze. Calcium nitrate was found to fulfill the requirements and, when 1% was added to the glaze batch and the specific gravity was 1.5, the consistency of the glaze was satisfactory for dipping the wall-tile tests. When the specific gravity was 1.3, the glaze was quite thick without the calcium nitrate.

Tests were run to establish a base glaze that would present a pleasing surface and also withstand an autoclave-crazing test to a satisfactory degree. The limits of the various oxides covered in this work are as follows:

ZnO	0	−0.40				
K_2O	0.20	−0.40				
CaO	0.20	−0.40	Al_2O_3 0.22–0.44	SiO_2	2.00	−4.00
BaO	0	−0.30		B_2O_3	0.30	−0.45
MgO	0	−0.24				

(2) Colors Added

The coloring materials used were added as a percentage of the glaze batch and were not calculated as a portion of the glaze formula.

(3) Preparation

All glazes were ground in a laboratory pebble mill for about one and one-half hours. They were washed with an excess of water which was siphoned off when the glaze had settled.

The glazes were applied to all tile tests by dipping, and the edges were fettled before firing. Several small pieces of pottery were glazed by washing the base glaze on the inside and spraying various colored glazes on the outside. The glazes applied very satisfactorily by both methods. The tests were fired in a gas-fired, downdraft, laboratory kiln, the firing schedule being about 20 hours.

Blending diagrams were used frequently in the base-glaze experimental work, and in each case the glazes were blended in the wet state after they had been brought to a uniform specific gravity. The colored glazes were blended in the same manner.

III. Results

The composition of the base glaze chosen for use in the colored series is given below.

Formula

ZnO	0.30				
K_2O	0.20				
CaO	0.25	Al_2O_3 0.22	SiO_2	2.50	
BaO	0.10		B_2O_3	0.375	
MgO	0.15				

Batch

Calcined zinc oxide	24.3
Buckingham feldspar	113.2
Colemanite	51.5
Barium carbonate	19.7
Steatite	18.9
Flint	66.0
Calcium nitrate	2.9

This glaze was semiopaque and had a surface which was not as brilliant as a bright lead glaze. It withstood three one-hour cycles in an autoclave at a pressure of between 50 and 75 pounds and crazed slightly during the fourth cycle. Fifteen freezing cycles failed to develop any crazing. Tests of this glaze have been fired between cones 1 and 4 with only a slight variation in surface appearance. At the lower temperature it is slightly duller. This glaze is quite viscous and does not flow on the vertical surface of the pottery tests.

All of the base-glaze tests having an appreciable quantity of zinc oxide and magnesium oxide were semiopaque. In the trials where barium replaced the zinc and magnesia, the resulting tests were quite transparent but crazed easily when subjected to the autoclave test. The barium oxide went into solution much easier than in a raw lead glaze and did not tend to dull the surface or cloud the glaze. This is probably due to the high acidity of the glaze.

The method of introducing the coloring materials into the glaze, as a percentage of the batch, had no effect on the maturity or the surface appearance. The general trend of the colors was toward the pastel shades. Each colored glaze was blended in equal parts with every other colored glaze.

The amounts of the coloring materials used and the numbers of the glazes in the blending diagram are as follows:

No.	Coloring materials (%)
1	Base glaze
2	5 copper carbonate
3	3 cobalt carbonate
4	8 red oxide of iron
5	10 manganese carbonate
6	3 green chromium oxide
7	5 green nickel oxide
8	8 commercial uranium oxide
9	5 chromate of iron
10	8 rutile
11	8 granular ilmenite

The results of the above colored glazes and their blends are as follows:

No.	Blend	No.	Blend
1	Semiopaque	2–4	Greenish gray-brown
2	Medium blue-green	2–5	Light green-gray
3	Dark blue-violet	2–6	Gray-olive green
4	Medium red-brown	2–7	Milky gray-green
5	Dark taupe	2–8	Medium gray-green
6	Medium gray-green	2–9	Milky blue-brown
7	Light pea green	2–10	Opaque medium green
8	Medium yellow-orange	2–11	Medium gray-green
9	Medium gray-brown	3–4	Dark gray-blue
10	Cream	3–5	Medium blue-biolet
11	Mottled light gray	3–6	Medium blue-green
1–2	Turquoise green	3–7	Medium blue-gray
1–3	Medium violet-blue	3–8	Dark gray-blue
1–4	Yellow-tan	3–9	Dark blue-gray
1–5	Medium violet-taupe	3–10	Opaque light blue
1–6	Light gray-green	3–11	Light gray-blue
1–7	Light pea green	4–5	Dark gray-tan
1–8	Light yellow	4–6	Autumn brown
1–9	Medium milky brown	4–7	Dark gray-brown
1–10	Cream-white	4–8	Red-tan
1–11	Light milky tan	4–9	Medium chocolate brown
2–3	Light medium blue	4–10	Light milky gray
		4–11	Milky gray-brown
5–6	Dull dark brown	6–11	Light red-brown
5–7	Light blue-gray	7–8	Yellow-green
5–8	Medium taupe	7–9	Drab-brown
5–9	Medium milky brown	7–10	Opaque light green
5–10	Light violet-taupe	7–11	Milky gray-brown
5–11	Medium gray-tan	8–9	Light chocolate brown
6–7	Medium olive-green	8–10	Yellow-cream
6–8	Medium green-gray	8–11	Light tan
6–9	Medium gray-brown	9–10	Light brown-gray
6–10	Light gray-green	9–11	Medium red-tan
		10–11	Mottled light gray

The numbers of the color blends, for example 3–10, indicate that the colored glaze, No. 3, containing cobalt carbonate, has been blended with an equal part of colored glaze No. 10, containing rutile. Blend number 5–6 was the only one which resulted in an unsatisfactory surface. The colors on buff body varied only slightly from those on white wall tile.

IV. Conclusions

A series of glazes of the type described could be used to good advantage in glazing art pottery. The different colors could be mixed in various proportions and combinations and an almost limitless number of colors produced. For glazing wall tile, where colors must be matched, the glazes should be made direct and ground individually.

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RED GLAZES AND UNDERGLAZE RED BY REDUCTION*

By C. M. Harder

Abstract

A firing procedure is formulated along the lines laid down by Seger for the production of copper red glazes and underglaze red. Possible methods of control of the liver red, cherry red, and purple-red *flambé* glazes are given.

I. Introduction

This series of experiments with the reduction of copper oxide was begun upon the theory that the occurrence of the various possible colors from that oxide was due more to variation of kiln atmosphere than to glaze composition. The first phase of the work was devoted to an attempt to determine the relative importance of those two factors and to establish the most dependable firing routine.

II. Glaze Formulas

Glazes of the following types maturing at cones 7 to 11 were used:

Glaze No. 1

K_2O	0.08	Al_2O_3 0.49	SiO_2	3.75
Na_2O	0.52		B_2O_3	0.695
CaO	0.40		SnO_2	0.06

Glaze No. 2

CaO	0.811	Al_2O_3 0.527	SiO_2	4.11
K_2O	0.188			

The amounts of copper carbonate used ranged from 1/4 of 1% to 1%. These glazes were cross-blended and placed at various levels in the kiln.

III. Firing Experiments

Firing was done in a downdraft gas-fired kiln of about twenty saggers' capacity with a 3½- to 4-cone temperature range from bottom to top.

The firing schedule was oxidizing up to 800, reducing from 800 to 1000°C, and alternately oxidizing and strongly reducing from that point to maturity.

The results showed evidence chiefly of over-oxidation. There were occasional flashes of red with greens, faint purples predominating in the upper ranges and black and green in the more fusible glazes. Variations of the above schedule produced similar results.

As the oxidizing periods in the last stage were shortened, the red color was more dependable in its occurrence, but it was more likely to contain unoxidized copper in the black form. Longer oxidizing produced more brilliant reds, but their appearance was less dependable. This checked so favorably with Seger's conclusions concerning copper reds that his firing schedule was adopted.

Some shade of red was developed in every case among the more fusible glazes. These, however, were often darkened by the presence of copper in the black form.

IV. Firing Schedule Adopted

The following mode of firing proved more successful for the type of kilns used and was adopted as a final schedule: oxidizing to 750°C; at this point all air intakes and dampers were closed as far as possible, still permitting a temperature rise of 35° to 40° per hour. An analysis of the kiln atmosphere during this stage showed a CO_2 content of 2 to 4% in the center of the firing chamber. By this means, a thick deposit of carbon was built up on the saggers and the ware until a temperature of 990°C was reached.

The kiln was then oxidized through a 100°-rise in forty-five minutes. At this temperature, an analysis showed 10 to 12% CO_2. The drafts were then closed only to the point where a slight pressure was obtained. The CO_2 content averaged 7%. This condition was maintained until maturity. One or two brief oxidizing periods during this stage seemed to make little difference in the color of the ware.

The reds developed by this schedule showed little evidence of completely reduced copper in the black form, which indicated that previous failures had been due to insufficient reduction in the first stage of firing and over-reduction in the latter stages. Subsequent kilns demonstrated the importance of a uniform draft during the final reducing and oxidizing periods.

V. Glaze Studies

The colors obtained with glaze No. 1 were chiefly of the deep red and so-called "liver red"

* Presented at the Annual Meeting, American Ceramic Society, Buffalo, N. Y., February, 1935 (Art Division).

variety. The most brilliant colors appeared on edges, places of moderately thin application, and at higher temperatures where the glaze had run. This bright color was developed more uniformly when this glaze was fluxed with 10% of the following frit:

Glaze No. 3

Na_2O	0.473	Al_2O_3 0.019	SiO_2	1.6
CaO	0.525		B_2O_3	0.36

A series of tests, varying the ingredients of the original glaze, produced some shade of red, the intensity varying only with the fusibility of the glaze.

Glazes high in lime or alumina showed a tendency to retain black copper at the lower temperatures and to re-oxidize to the green form at higher temperatures, many times holding copper in three stages of oxidation to produce the purply splotches so common to Chinese ware of the Sung period.

This purple could be maintained uniformly over the surface of a piece by supplying the calcium content with colemanite in the following glaze maturing at cones 9 to 10. Soda was introduced through the use of a soda feldspar.

Glaze No. 4

CaO	0.77		
K_2O	0.083	Al_2O_3 0.310	SiO_2 3.15
Na_2O	0.148		

Upon increasing the soda in this glaze, the color immediately shifted toward red. Violent displays of color were evident, if a light spray of glaze No. 3 was applied to the high-lime glaze.

At cones 10 and 11, glazes No. 2 and No. 4, containing less than 1% of copper carbonate, usually oxidized to the green form. These were changed to various shades of pink by increasing the amount of copper up to 2% and by prolonging the initial reducing period to 1075°C and oxidizing from that point to 1150°C.

The pinks were more pronounced when a soda feldspar and about 3% of steatite were added to glaze No. 2. The effects were quite similar to Chinese specimens known as "peach blow." The formula of this glaze is given below.

Glaze No. 5

CaO	0.762		
Na_2O	0.094	Al_2O_3 0.45	SiO_2 4.135
K_2O	0.053		
MgO	0.091		

Attempts to produce a clear bright red at cone 11 failed. Thin applications of the following glaze produced a cherry red at cones 9 and 10; when thickly applied, the purple color appeared.

Glaze No. 6

Na_2O	0.123	Al_2O_3 0.394	SiO_2	3.71
CaO	0.734		B_2O_3	0.123
K_2O	0.143			

Red glazes similar to glaze No. 1 were refired in an oxidizing atmosphere to cone 03 with no apparent change in color. Test glazes, refired oxidizing to 750° and reduced for ten minutes, showed no change except the formation of a film of metallic luster over the surface. Under prolonged reduction at this temperature in previously oxidized tests of the softer glazes, the luster showed a tendency to penetrate the glaze and form a surface red of the dark liver-red type.

A series of tests was run at cones 06 to 02. The firing schedule was altered to conform to the fusibility of the glaze. Reduction was begun at 600° and continued to 860°, oxidized from 860° to 960°, and reduced to maturity. Reds were uniform throughout the kiln and seemed to be less susceptible to changes in kiln atmosphere than those at higher temperatures.

The following glaze fired to cone 07 is typical of this group:

Glaze No. 7

K_2O	0.059	Al_2O_3 0.365	SiO_2	2.0
Na_2O	0.432		SnO_2	0.04
CaO	0.262		B_2O_3	0.525
PbO	0.245			

(1) Underglaze Red

The following observations were made on the use of copper oxide as a source of underglaze red: (1) The colors were most reliable when the underglazes contained at least 0.2% of soda. (2) There was a tendency to leave the body and diffuse into the glaze unless both color and glaze were applied thinly. (3) Reds were produced by very thin sprays of copper oxide underneath a soft soda glaze. (4) The firing must be the same as that for the red glazes themselves. (5) The following batch proved the most reliable: tin oxide 20, copper 25, glaze No. 6 20, and calcined clay 35.

VI. Conclusions on Copper Red Glazes

(1) Intense reduction before the fusion of the glaze must be followed by a period of oxidation during fusion to bring copper completely to the

red form. This must be followed by a reducing period to prevent reoxidation.

(2) Oxidation must be complete and must continue until the glaze has fused.

(3) The brightest colors occur most frequently below cone 9 and in thinner applications of a fusible soda glaze.

(4) The purple colors, which are a mixture of copper in the blue-green oxidized form and copper in the red reduced form, appear most frequently in glazes high in lime. Similar effects may be obtained in more fusible glazes by an earlier period of oxidation and by a neutral firing condition in the latter stages of firing.

(5) Consistent development of the red color is dependent upon two conditions, *viz.*, (1) uniform evenly circulating kiln gases and (2) the proper relation of firing procedure to glaze fusibility.

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Compiled by the

AMERICAN CERAMIC SOCIETY

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The bold-face number following the journal name is the volume; the issue number is in brackets, followed by the page numbers, then the year in parentheses.

Vol. 15 **January, 1936** **No. 1**

Abrasives

Abrasives in metal polishes. Cyril S. Kimball. *Chem. Industries*, **34** [3] 209–14 (1934).—Metal polish must primarily clean and secondarily produce a luster. Scratching is necessary to produce a satisfactory luster. There are four competitive types of liquid polishes on the American market: neutral naphtha-base, naphtha-base ammonia, water-base pine-oil, and water-base ammonia type. Of six or eight abrasives that might possibly be used in metal polishes, silica is the only one which has been extensively used. The type of abrasive required for the different polishes is discussed. M.J.H.

Grinding and polishing agents. F. Weiss. *Oberflächentech.*, **12** [17] 209–10 (1935).—During recent years, several very hard substances of high chemical resistance and high melting point have been developed for grinding and polishing purposes. The Norton Co. (Canada) has found a commercial process for the manufacture of boron carbide which is similar to Carborundum. Tungsten carbide is made by melting tungstic acid, Fe, and coal in an electric furnace. For grinding of very hard tools, titanium carbide and zirconium carbide are used. For polishing purposes, pastes of alumina have recently been employed, especially for polishing Al and Al alloys and for Cr-plated articles and stainless steels. Alumina pastes are preferable to the often-used chromium oxide pastes as the dust is not so harmful to the operator as the Cr dust and is not so toxic as the latter. Zirconium dioxide (ZrO_2) is used for polishing Cr, stainless steel, and hard Ni deposits; although the results are very good, it is not yet possible to manufacture it with sufficiently uniform grain size for industrial use. Eleven references. M.H.

Nature of polished layers of metals. M. Miwa. *Sci. Repts. Tôhoku Imp. Univ.*, **24** [2] 222–39 (1935).—Polished surfaces of various metals were examined by means of cathode rays. The diffraction patterns show that the surface layer of most polished metals is amorphous, with the exception of cadmium, tin, and antimony. The surfaces were studied at various stages of polishing, and the results were found to support the theory of the amorphous layer. Because no precise distinction of the amorphous layer and the ultimate limit of a crystalline state is yet possible, it is assumed that the true nature of the polished surface is intermediate between the two states. W.M.C.

Polishing cast iron. Fred B. Jacobs. *Metal Cleaning & Finishing*, **7** [10] 507–509 (1935).—Typical procedures, abrasive grits, and types of abrasive wheels used in the polishing of cast-iron parts are discussed. The size of the abrasive grit varies from No. 24 to No. 180, depending upon the finish desired and method used. E.J.V.

Properties of abrasive polishes: II. Alfred B. Searle. *Soap*, **10** [2] 23 (1934).—The consistency of a polish has an important influence on its properties. Polishes are supplied in three forms: powders, pastes, and so-called liquids, which are essentially suspensions of the solid ingredients in the vehicle. For best results the composition and physical properties of the polish must be adapted to the material to be polished. Homogeneity is an essential property of all high-grade polishes. Defects in polishes are discussed. These are mainly dull appearance in the container, drying and shrinkage in the container, separation of the polish into two phases, sedimentation, corrosion of the polished surface by the polish, low polishing power, poor finish, and the development of a "bloom" or moldy appearance after polishing. For Part I see *Ceram. Abs.*, **13** [6] 137 (1934). M.J.H.

BOOKLETS

Abrasives, their history and development. Norton Co. 30 pp. Reviewed in *Foundry*, **62** [12] 76 (1934).—This booklet also presents information on the development and

manufacture of both aluminum oxide and silicon carbide abrasives. F.G.H.

Dressing and truing grinding wheels. H. J. WILLS. Reviewed in *Foundry*, **62** [10] 112 (1934).—This booklet includes a description of wheel dressers, the general application of abrasive-wheel dressers, diamond recommendations for specific applications, and general rules for the application of diamond tools and for miscellaneous truing and dressing. F.G.H.

Grinding of cemented carbides. CARBORUNDUM CO. Reviewed in *Foundry*, **62** [11] 86 (1934).—A discussion on the grinding of cemented carbides and information on factors affecting grinding-wheel action are presented in this booklet. F.G.H.

High-speed abrasive wheels bonded with bakelite resinoid. BAKELITE CORP. 24 pp. Reviewed in *Power*, **78** [12] 702 (1934).—This booklet describes the applications of bakelite products in various types of abrasive wheels. F.G.H.

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Abrasive machine. W. W. PRICE AND C. W. RIPSCH (Buckeye Portable Tool Co.). U. S. 2,016,725, Oct. 8, 1935 (July 6, 1931).

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Centerless cylindrical grinding machine. HEINRICH BECKER. U. S. 2,016,478, Oct. 8, 1935 (Nov. 12, 1930).

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Control mechanism for grinding machines. H. A. SILVEN (Norton Co.). U. S. 2,016,932, Oct. 8, 1935 (Aug. 13, 1934).

Cutting, grinding, and burnishing tool and the production thereof. A. E. JOHNSTON (Calibron Products, Inc.). U. S. 2,020,117, Nov. 5, 1935 (May 21, 1930).

Flexible abrasive-coated articles and the manufacture thereof. CARBORUNDUM CO., LTD. Brit. 434,186, Sept. 11, 1935 (Feb. 22, 1934).

Grinding apparatus. F. A. THOMPSON. U. S. 2,016,351, Oct. 8, 1935 (Nov. 3, 1934).

Grinding machine. HANS ERNST (Cincinnati Grinders, Inc.), U. S. 2,020,541, Nov. 12, 1935 (Sept. 8, 1933). W. F. FRASER, U. S. 2,018,847, Oct. 29, 1935 (July 6, 1932). F. S. HAAS (Cincinnati Grinders, Inc.), U. S. 2,020,547, Nov. 12, 1935 (Nov. 4, 1933). L. E. ROSS, U. S. 2,021,024, Nov. 12, 1935 (Oct. 22, 1934).

Grinding wheel for bristles. W. S. ELLIOT (Pro-Phy-Lac-Tic Brush Co.). U. S. 2,017,487, Oct. 15, 1935 (May 28, 1935).

Guide block for engine cylinder grinding machines. JOSEPH SUNNEN. U. S. 2,020,589, Nov. 12, 1935 (April 30, 1932).

Honing apparatus. R. O. HARPER. Brit. 434,500, Sept. 18, 1935 (March 8, 1934).

Hydraulic feed. H. J. BREITENBACH (Lodge & Shipley Machine Tool Co.). U. S. 2,020,765, Nov. 12, 1935 (June 28, 1928).

Lapping machine. F. J. THELER, G. V. JOHNSTON, AND WILLETTS PEASLEE. U. S. 2,017,875, Oct. 22, 1935 (Dec. 5, 1932).

Lapping or grinding devices for crank pins. E. GÖTTI. Brit. 435,897, Oct. 16, 1935 (Nov. 21, 1933).

Manufacture of abrasive bodies. P. VÖGELI-JAGGI AND DIAMANT-SCHLEIFEREI VOEGELI & WIRZ A.-G. Brit. 434,402, Sept. 11, 1935 (April 27, 1934).

Manufacture of abrasive wheels. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 436,430, Oct. 23, 1935 (March 17, 1934).

Manufacture of artificial grindstones for pulp grinding. R. C. BENNER (Carborundum Co.). U. S. 2,017,228, Oct. 15, 1935 (Nov. 14, 1934).

Manufacture of silicon carbide. H. P. KIRCHNER (Carborundum Co.). U. S. 2,018,133, Oct. 22, 1935 (Aug. 2, 1933). In a raw batch for the manufacture of silicon carbide in an electric furnace, the batch contains, in addition to sand, carbon, and salt, a small proportion of buckwheat hulls.

Method of cleaning abrasive surfaces. C. A. MARIS (George P. Kimmel). U. S. 2,015,603, Sept. 24, 1935 (Dec. 13, 1932).

Method and device for grinding and polishing metallic coverings. GRUMPELT PROPELLERBAU GES. Brit. 434,256, Sept. 11, 1935 (Oct. 30, 1934).

Method of making an abrasive tool. G. F. TAYLOR (General Electric Co.). U. S. 2,014,955, Sept. 17, 1935 (May 6, 1933).

Polishing machine. EDWARD CULVER (United Kingdom Optical Co.). U. S. 2,016,134, Oct. 1, 1935 (Feb. 15, 1934).

Polishing wheel. F. F. HILLIX (United States Platers Supply Co.). U. S. 2,015,646, Sept. 24, 1935 (March 22, 1933).

Precision metal-cutting, grinding, or like machine tools. SOC. GENEVOISE D'INSTRUMENTS DE PHYSIQUE. Brit. 435,714, Oct. 9, 1935 (April 23, 1934).

Process of disintegration of ceramic bonded articles. A. P. THOMPSON (Carborundum Co.). U. S. 2,019,062, Oct. 29, 1935 (July 18, 1933). A process of recovering grain from bonded granular bodies comprises subjecting lumps of such bodies to disruptive physical forces and then subjecting the disrupted masses to the action of chemical reagents for further freeing the grain from the bond.

Rail grinder. C. A. MILLER. U. S. 2,018,411, Oct. 22, 1935 (Aug. 22, 1934).

Rotary bonded abrasive articles. A. H. PREV (Carborundum Co.). U. S. 2,015,717, Oct. 1, 1935 (Dec. 1, 1933).

Surface grinder. G. T. HUXFORD (Builders Iron Foundry). U. S. 2,019,677, Nov. 5, 1935 (Aug. 25, 1934).

Thermostatic control for grinding machines. H. E. BALSIGER (Landis Tool Co.). U. S. 2,019,040, Oct. 29, 1935 (Feb. 15, 1934).

Timing device for cam grinding machines. C. L. OTT (Landis Tool Co.). U. S. 2,019,088, Oct. 29, 1935 (July 10, 1930).

Tool grinding machine. P. T. LENNON. U. S. 2,017,465, Oct. 15, 1935 (Jan. 22, 1931).

Trimming mechanism for grinding wheels. A. H. ORCUTT (Gear Grinding Co., Ltd.). U. S. 2,018,145, Oct. 22, 1935 (May 9, 1935).

Workholder for sharpening machines. LEO STEINER. U. S. 2,019,742, Nov. 5, 1935 (Nov. 25, 1932).

Art and Archeology

Art schools and industry: I-II, Stoke-on-Trent. ANON. *Studio* [London], **103**, 223–27, 275–83 (1932).—The art schools at Stoke-on-Trent are a recruiting ground for the pottery industry. The training extends over a period of five years. Illustrations represent the work of students at the school. G.H.A.

Artistic ceramics from clay which turns red on firing. W. P. *Sprechsaal*, **68** [13] 193–95 (1935).—Clays which turn red on firing are especially suitable for obtaining artistic ware at a low temperature. The clay should contain some fine sand and from 5 to 8% iron oxide; soda (0.2 to 0.3%) and water-glass (0.6 to 0.8%) are used to liquefy the slip. A series of glazes for this ware is discussed. M.V.C.

British pottery design. H. TRETHOWAN. *Studio* [London], **106**, 181–88 (1933).—The application of modern decoration to existing shapes has led to a redundancy of colored bands and lines. The pottery of today should express contemporary form and fashion. Illustrated. G.H.A.

Charm of the potter's craft. W. A. DE SAGER. *Studio* [London], **108**, 259 (1934).—The fascination and development of pottery as a hobby is described. G.H.A.

Connoisseur in America. HELEN COMSTOCK. *Connoisseur*, **96** [409] 164–65 (1935).—A collector's edition of porcelain plates bearing subjects from Birds of America by John James Audubon has been issued by the Royal Worcester Porcelain Co. at the suggestion of the Dickins Publishing Firm to commemorate the centenary of that book. They are on exhibition at the William F. Cooper gallery. The long disused process of "honey gilding," in which the powdered gold is mixed with beeswax and honey, has been revived for the purpose. Illustrated. E.B.H.

Design in pottery. ANON. *Studio* [London], **110**, 267 (1935). An illustrated review is given. G.H.A.

English pottery. G. GRIGSON. *Studio* [London], **110**, 256–65 (1935).—The English quality in pottery is defined as solid, plain, and naturalistic. Its form is more romantic than classical. It is traditional that the decoration fits the shape. Illustrations are drawn from the summer exhibition at the Victoria and Albert Museum, London. These show that modern studio potters have not captured the traditional spirit. On the other hand, the Doulton commercial stoneware and laboratory porcelain is excellent technically and in design. G.H.A.

Fine craftsmanship. C. G. HOLME. *Studio* [London], **105**, 61–68, 129–36, 199–206, 335–42; **106**, 113–22 (1933).—The selection includes contemporary pottery and glassware, illustrated and described. G.H.A.

Flora Danica Service. VICTOR P. CHRISTENSEN. *Connoisseur*, **96** [407] 28–29 (1935).—The decoration of the Flora Danica Service was executed from Danish plants, the originals being supplied by the Botanic Gardens and the botanical name being inscribed on each piece It is now in the Rosenberg Castle, near Copenhagen. Illustrated. E.B.H.

Gardner and other Russian porcelain factories. ALEXANDER POPOFF. *Connoisseur*, **96** [408] 68–73 (1935).—The work of Francis Gardner, Anglo-Russian potter, might be divided into the unofficial period of experimentation in technique and locality and the official period from 1765 when he opened a factory near Moscow. To the first period belong statuettes and tiny tea sets, marked only with an impressed circle and a mark in blue, generally well modelled, of good quality paste, and painted in a delicate scheme of coloring (apple green, very light raspberry, and yellow) met with nowhere else. In the second period, in which he signed with a *G*, he executed royal commissions for dinner services for the orders of Sts. George, Andrew, Alexander, and Vladimir. He openly borrowed from German ceramists and from other factories, noticeably a beautiful dull blue from the Imperial factory. The Gardner factory remained in the family for 136 years. The factory of Alexis Popoff, in the province of Moscow, having for its mark the Russian *A* and *P*, produced tableware or ornaments of fine paste with rich gilding and brilliant coloring and competed seriously with the Imperial factory. The predominant colors were chestnut brown and light blue. Its best period was 1830. Other prominent factories in Russia were Mejigoriay, the Poskochin at Moriay, the factory of Prince Youssoupoff near Moscow which only decorated ware used as gifts, the large factory of the Korniloff Bros. employing the French ceramist Auguste Darte, and the factory of Milklashevsky, managed for a period by Darte. A number of small factories produced common tableware and many rather coarse but amusing figurines. Illustrated. E.B.H.

Ice-flower patterns on sheet glass without glue. ANON. *Glashütte*, **65** [8] 116–17 (1935).—A large sheet of fabric of coarse web structure is dipped into sandblast resist, rolled, and applied to sheet glass by unrolling along the surface. This gives a distribution of the paste in an irregular form which is similar to the ordinary ice-flower pattern. An after-treatment with a sandblast makes this design permanent. Illustrated. M.V.C.

International standardization of colors. A. MAERZ. *Jour. Amer. Ceram. Soc.*, **18** [11] 361–66 (1935); *Bull. Amer. Ceram. Soc.*, **14** [10] 349–53 (1935).

Majolica enamels. H. J. KARMAUS. *Sprechsaal*, **68** [16] 241–43; [17] 257–59 (1935).—A series of majolica enamels is analyzed and their application is briefly discussed. M.V.C.

Medieval glassmaking. S. E. WINBOLT. *Connoisseur*, **96** [408] 91–92 (1935).—In the vast forest which once covered Sussex and Surrey, folds (clearings) were made for villages and pastures and here the first glassmakers settled. Remains of thirty or more furnaces have been found. W. concisely describes the furnaces, type of glass, blowing, distribution, etc. Illustrated. E.B.H.

Mexgila pottery. MARK E. MUSSBAUM. *Design*, **37** [3] 24–25 (1935).—The Gila monster is the inspiration for this pottery and the name is a combination of Mexico and Gila. The pottery, handmade, is very heavy, glazed on the inside, and given three coats of paint (black for the ground with red and yellow) and two of shellac which make it almost watertight. The light brown clay is similar to adobe but its exact source is known only to the makers. It is crushed, screened, mixed with water, and worked in a pit for about an hour. Strained and sun-dried, it is again liquefied and vat-dried. The hard clay is moistened and kneaded into a doughy mass when it is ready for the wheel or torno. The firing is done in a crude kiln of adobe brick, the fire not touching the ware. It is very brilliant. Illustrated. E.B.H.

Modern ceramics and the museum. WILLIAM M. MILLIKEN. *Bull. Amer. Ceram. Soc.*, **14** [11] 382 (1935).

Naples yellow, a refractory underglaze pigment. LUDWIG STUCKERT. *Sprechsaal*, **68** [21] 321–24; [22] 337–39; [23] 353–55; [24] 369–73 (1935).—The temperature-time curves between 400 and 1000°C of reaction groups Sb_2O_3/PbO, Sb_2O_3/ZnO, Sb_2O_3/Al_2O_3 and their mixtures are discussed. The formation of antimony compounds with lead oxide and zinc oxide occurs at 440 to 450°. An aluminum compound of antimony oxide could be produced with γ-aluminum oxide and not the usual α-Al_2O_3. This formation occurs at 800° with a high liberation of heat. The presence of a gas phase in the form of oxygen affects the oxidation of the antimonites first formed into antimonates. The degree of oxidation lies between 86 and 96%. The progress of oxidation as a function of temperature, with a definite rate of increase of the latter, was determined for the group $Sb_2O_3/PbO/O_2$ and $Sb_2O_3/ZnO/O_2$. The degree of oxidation at definite temperatures was determined for the other groups. The rate of oxidation of lead and zinc antimonites increases with a progressive basicity of the compounds formed. It was found that the kind of antimonite formed at the beginning affects decisively the course of the oxidation curves. The reactions proceed by stages in some groups. The mixtures Sb_2O_3 + PbO and Sb_2O_3 + 2PbO change into meta- and pyro-antimonate between 700 and 750°C with a development of heat. The course of the formation of compounds occurs by stages in the mixed groups $Sb_2O_3/2PbO/ZnO/O_2$ and $Sb_2O_3/2PbO/Al_2O_3/O_2$. Sb_2O_3 reacts with ZnO at first, while PbO combines with the zinc antimonate at higher temperature. The heat tones of a series of reactions were determined through the introduction of oxygen and thermochemical equations set up. The heat of formation of antimonates from the oxides was calculated and qualitatively proved by means of temperature curves. Only low thermal effects occur when heating PbO and Sb_2O_3. The heat tones appearing with the transformation of ortho-antimonates into meta- or pyro-antimonates were calculated. The thermal effects and the temperatures of formation were determined. The heat of formation of a series of compounds was found from the heat of reaction obtained. X-rays showed only two independent interference systems in lead antimonates. Zinc antimonate showed the same position of lines. Antimonates obtained from Sb_2O_3 and γ-Al_2O_3 show a specific interference picture. The lines of mixed antimonates of Pb and Zn and Pb and Al show great similarity with the lines of Pb-antimonate; both double antimonates are chemical compounds of the same character as orthoantimonates. The additions of common salt when producing Naples yellow of any composition is injurious. The intensity of color is increased little when introducing ZnO in lead pyroantimonate. The increased addition of ZnO markedly lowers the refractoriness of the material. Al_2O_3 increases refractoriness but lowers the intensity of the color. The simultaneous introduction of Al_2O_3 and ZnO increases the refractoriness of the pigment from cone 02*a* to cone 2*a*. The refractoriness of the pigment increases to cone 5*a* when iron oxide is introduced in the presence of Al_2O_3 and ZnO. The stability fields of Naples yellow were determined by means of the Gibbs triangles. M.V.C.

Old Roman pottery in England. ANON. *N. Y. Times Mag.*, p. 20 (Oct. 6, 1935).—Proof of the manufacture of glass and pottery during the Roman occupation of Britain has been found at Prestatyn, a Welsh village near Chester. Among the relics unearthed was a bit of millefiori glass, a rare Roman product, deep blue in color with white floral designs. M.V.C.

Products of the Steinschönau Technical School for the glass industry. O. KLETZL. *Glashütte*, **65** [1] 3–5(1935).—Illustrations are given of ornamental glassware. Engravers and painters of the school have revived the technique of a hundred years ago in the production of cups, bowls, drinking goblets, and glass paintings. M.V.C.

Relationship between antique ceramics and sigillata. F. LOSSEN. *Sprechsaal*, **68** [7] 98–100 (1935).—The characteristics of ancient ceramic ware are discussed. M.V.C.

Revival of Indian pottery. ANON. *Design*, **37** [3] 26–27 (1935).—The revival of the pottery work abandoned years ago by the Pamunkey Indians in Virginia has been encouraged by Van Oot of the Board of Education with the actual instruction and guidance of W. E. Ross. The clay is local and is made by the well-known coil method and by pressing sheets of clay over fired clay molds made and decorated by the Indians. The colors and designs are symbolic picture writing and geometric. An interesting finish, especially for modelled or indented pieces is procured by burning the pottery to a glossy black in a smoky outdoor fire of pine tags and bark. The Indian women work with sincerity and enthusiasm. It is hoped that the sale of their pottery may prove of financial aid to the Indians. Illustrated. E.B.H.

Robineau Memorial Ceramic Exhibition prize winners. ANON. *Bull. Amer. Ceram. Soc.*, **14** [11] 377–78 (1935). Illustrated.

Service plates of Episcopal churches of New Jersey. W. W. KLENKE. *Ceram. Age*, **24** [1] 10–11 (1934).—The service plates prepared in honor of the twenty Colonial Episcopal churches of N. J. are described and illustrated. F.G.H.

BOOKS AND BULLETINS

Archeological Investigations in the Bay Islands, Spanish Honduras. W. D. STRONG. *Smithsonian Inst. Pub.*, No. 3290, 176 pp. Reviewed in *Ceram. Age*, **26** [2] 75 (1935).—Burial urns, old rum bottles, monochrome and

polychrome vases, and numerous specimens of vessels and pottery are illustrated in thirty-three halftone plates. F.G.H.

Art and Industry. Principles of Industrial Design. H. READ. Faber and Faber. Price 12s 6d. Reviewed in *Times Lit. Supp.*, **33**, 888 (1934). G.H.A.

Catalog of the Glaisher Collection of Pottery and Porcelain in the Fitzwilliam Museum, Cambridge. BERNARD RACKHAM. 2 vols. Cambridge Univ. Press. Price 10 guineas. Reviewed in *Connoisseur*, **96** [408] 99 (1935); *Times Lit. Supp.*, **34** [1753] 547 (1935).—The catalog describes the collection comprising over 3000 objects, including blue and white delft earthenware, English delft, slipware, salt-glazed ware, and porcelain, adding some from the Continent. The text is divided into two parts, pottery and porcelain. Section 5 of the lead-glazed earthenware treats of the industrial potteries. Volume I contains the text and 37 illustrations in color. Volume II has 266 collotype plates by Emery Walker, Ltd. E.B.H.

Guide to Italian Majolica. B. RACKHAM. 97 pp. Price 5s. Reviewed in *Times Lit. Supp.*, **33**, 542 (1934).—This guide is intended to serve as the introduction to a new detailed catalog to be published later. Illustrated. G.H.A.

Investigation on Impure Spectra. C. VILLALOBOS. Dominguez, Buenos Aires. Reviewed in *Studio* [London], **103**, 179 (1932). G.H.A.

Palace of Minos at Knossos. ARTHUR EVANS. Macmillan, New York, 1935. 4 vols. Price $145.00. With publication of the fourth volume of the discoveries at Knossos, the complete record of forty years of exploration on the island of Crete is available. **Volume I.** 721 pp. 542 figs., map, 7 colored plates, 11 supplementary plates. Price $40.00. The Neolithic, and Early and Middle Minoan ages are covered. **Volume II (Part 1).** 390 pp. Figs. 1–223, 4 maps, 2 colored plates, and 8 supplementary plates. Additional information on origins and external relations is given. The restoration in town and Palace after the seismic catastrophe toward the close of Middle Minoan III, and the beginnings of the new era are covered. **Volume II (Part 2).** 493 pp. Figs. 224–559, map, 5 colored plates, 11 supplementary plates, and general plans of Palace. Price of Parts 1 and 2, $45.00. Town houses in Knossos of the new era and the restored West Palace Section with its state approach are discussed. **Volume III.** 367 figs., 13 colored plates, 11 supplementary plates, and plans of "Domestic Quarter." Price $40.00. This volume includes a description of the great transitional age in the northern and eastern sections of the Palace. The most brilliant records of Minoan art and evidences of an advanced religion are disclosed. **Volume IV (Part 1).** 378 pp. Figs. 1–315, 4 colored plates, 10 supplementary plates, and restored plan of entrance system and *piano nobile* of West Palace as revised in 1932. The emergence of the outer western *enceinte* is discussed. New artistic and religious illustrations of the Middle Minoan phase are shown. The Chryselephantine "Lady of Sports" and the "Snake Room" with a full story of the cult are included. The late Minoan ceramic evolution and the "Palace Style" are included. **Volume IV (Part 2).** 639 pp. Figs. 316–966, 5 colored plates, 17 supplementary plates, and restored plans and sections of the upper story of the Temple Tomb of the last Priest-Kings. Price of Parts 1 and 2, $60.00. The "Camp-Stool" fresco is described. The Chryselephantine Boy-God and the ritual hair offering are discussed. Intaglio types from Middle Minoan III to Late Minoan II, are included. Late hoards of sealings, deposits of inscribed tablets, and the Palace stores are shown. The linear script, *B*, and its mainland extension are described. The closing Palatial phase and the final catastrophe, a series of cataclysmic earthquakes, are discussed. The findings published in this monumental work show that classical Greek civilization was not only preceded by, but actually rooted in, the Minoan culture of Crete and that of Mycenae on the Continent. At Knossos, the stratigraphic evidence goes back without a break to remote Neolithic times.

Evidence that the art of writing began with the Minoans is presented; reproductions of their writings show successive stages beginning with rude photography and advancing through a conventionalized hieroglyphic signary to fully developed linear script. The number of clay tablet documents unearthed reveals that the Minoans had elaborate systems of written records.

On the site of Knossos, excavations continued during the last thirty-five years indicate that the Palace of Minos covered six acres of ground. The successive stages of its development are shown in these volumes as well as that of the civilization from B.C. 3400 to B.C. 1200 which centered about this palace. HENRY H. SMITH

Prehistoric Assyria: Excavations at Tall Arpachiyah, 1933. Vol. 2, Part 1. M. E. L. MALLOWAN AND J. CRUIKSHANK ROSE. Oxford University Press, London. Price 1 guinea. Reprinted from "Iraq." Reviewed in *Times Lit. Supp.*, **34** [1753] 550 (1935).—Ten successive levels were excavated. The five upper layers contained pottery of the Al-'Ubaid type, but the lower levels yielded beautiful specimens of polychrome pottery, evidence of a superior artistic culture. Illustrated. G.H.A.

World of Colour. D. KATZ. Translated by Kegan Paul. Price 15s. Reviewed in *Times Lit. Supp.*, **34** [1753] 546 (1935).—This is an abridged translation of Katz's Der Aufbau der Farbwelt, 1930. G.H.A.

PATENTS

Designs for:

Article of glassware. R. A. MAY (Duncan & Miller Glass Co.). U. S. 97,082, Oct. 1, 1935 (Jan. 25, 1935).

Baby bath lavatory. W. C. GROENIGER AND R. L. DAVISON. U. S. 97,281, Oct. 22, 1935 (Aug. 16, 1934).

Bottle. G. M. CLEVENGER (Maryland Glass Corp.), U. S. 97,178, Oct. 15, 1935 (Aug. 3, 1935). FRANK MCLAUGHLIN (Carr-Lowrey Glass Co.), U. S. 97,198, Oct. 15, 1935 (July 5, 1935). FRASIER SMITH (Hazel-Atlas Glass Co.), U. S. 97,211, Oct. 15, 1935 (June 29, 1935), and U. S. 97,512, Nov. 12, 1935 (July 16, 1935). J. H. STEUERNAGLE (Brockway Glass Co., Inc.), U. S. 97,212, Oct. 15, 1935 (Aug. 24, 1935), and U. S. 97,339, Oct. 29, 1935 (Aug. 16, 1935).

Brick. ANDREW BOWLAND. U. S. 96,895 to 96,897, Sept. 17, 1935 (Jan. 29, 1935).

Cup. R. G. COWAN (Onondaga Pottery Co.). U. S. 97,119, Oct. 8, 1935 (Jan. 28, 1935).

Fish jar. M. S. DESSER (Owens-Illinois Glass Co.).

U. S. 97,041, Oct. 1, 1935 (Aug. 8, 1935).

Glass dish. EVERETT WORTHINGTON AND FINDLEY WILLIAMS (McGraw Electric Co.). U. S. 97,108 and U. S. 97,109, Oct. 1, 1935 (July 27, 1935).

Jar. E. W. FUERST (Owens-Illinois Glass Co.), U. S. 97,478, Nov. 12, 1935 (Sept. 21, 1935). FRASIER SMITH (Hazel-Atlas Glass Co.), U. S. 97,102, Oct. 1, 1935 (July 31, 1935).

Plate. S. H. SLOBODKIN, U. S. 97,442, Nov. 5, 1935 (Aug. 28, 1935). JOSEPH STETSON. U. S. 97,338, Oct. 29, 1935 (July 29, 1935).

Porcelain lighting fixture. R. G. COWAN (Pass & Seymour, Inc.). U. S. 97,039, Oct. 1, 1935 (July 15, 1935).

Tumbler. A. L. KEY (Hazel-Atlas Glass Co.), U. S. 97,486, Nov. 12, 1935 (Aug. 29, 1935). J. E. SPENCE (Hazel-Atlas Glass Co.), U. S. 97,103, Oct. 1, 1935 (July 19, 1935).

Red glaze. ANDREW MALINOVSZKY AND A. L. BENNETT (Malinite Products, Inc.). U. S. 2,020,559, Nov. 12, 1935 (April 10, 1933). A process of producing ceramic bodies provided with brilliant glazes of the character described comprises the steps of (1) applying a glazing material containing a selenium stain and a frit to a ceramic body, the frit containing about 7.5 to 15% B_2O_3, about 10 to 22% PbO, not more than about 5% Al_2O_3, and being practically free from tin, the remainder being composed principally of silica; (2) subjecting the ceramic body and glazing material carried thereby to a heat sufficient to cause the glazing material to reach a maturing temperature in from 10 min. to not more than about 4 hr.; and (3) cooling the glazed body.

Cements

Cements unaffected by very pure water. P. DUMOLARD. *Génie Civil*, **104** [26] 584–86 (1935).—An extended abstract of the published data is given. J.D.G.

Ciment fondu. R. D. *Verre & Silicates Ind.*, **6** [19] 360–61 (1935).—The discovery, chemical composition, and applications of *ciment fondu* are discussed. M.V.C.

Composition of aluminous cements. M. A. TRAVERS. *Ciment*, **39** [11] 293–95; [12] 327–31 (1934); **40** [1] 11–13 (1935); abstracted in *Referat. Silikatliteratur*, No. 1437 (1935).—Cements composed of $CaO{\cdot}Al_2O_3$, β-$2CaO{\cdot}SiO_2$, and $2CaO{\cdot}Fe_2O_3$ and those composed of $3CaO{\cdot}5Al_2$, $CaO{\cdot}Al_2O_3$, and gehlenite are discussed in detail. The properties of these cements and their advantages over Portland cement are dealt with. See also *Ceram. Abs.*, **14** [3] 61 (1935). M.V.C.

Effect of calcium fluoride on the thermal synthesis of calcium ferrites. S. NAGAI AND T. YOSHIURA. *Jour. Soc. Chem. Ind.* [Japan], **38** [8] 374–76*B* (1935).—The results obtained are given in tables. M.V.C.

Effects of fluorides on the thermal synthesis of calcium aluminates. I. S. NAGAI AND T. YOSHIURA. *Jour. Soc. Chem. Ind.* [Japan], **37** [11] 693–95*B* (1934).—Tables show the effect of different amounts of calcium fluorides on calcium aluminates. M.V.C.

Elasticity of cement and concrete, either plain or reinforced. EDMOND MARCOTTE. *Génie Civil*, **104** [22] 491–93 (1935).—Numerous data are given illustrating the elasticity of concrete and cement under different conditions. J.D.G.

Hydraulic cements. F. M. LEA. *Sci. Prog.*, **30**, 31–41 (July, 1935).—The evolution of modern cements is traced, with ternary diagrams and a microphotograph, from Smeaton's discovery when engaged on the Eddystone lighthouse, in 1756, to the latest aluminous cements. H.H.S.

Origin of the gypsum deposits near Sandusky, Ohio. VERNER JONES. *Econ. Geol.*, **30** [5] 493–501 (1935).—Workable deposits of gypsum are located in Portage township, Ottawa County, Ohio, with the village of Gypsum as the center of activity. The theory of origin most generally accepted is that of "precipitation from basins of water charged with salt, sulfate of lime, etc." Most of the evidence indicates that the original precipitate of calcium sulfate was of the anhydrous form. The deposits at Gypsum, Ohio, are thought to represent hydration products from deeper lying anhydrite beds and lenses. Illustrated. J.L.G.

Phenomena of firing in the manufacture of Portland cement. V. *Rev. mat. constr. trav. pub.*, No. 312, pp. 209–14 (1935).—The study of the reactions produced in the furnace during the firing of Portland cement made by M. W. Watson and Q. L. Craddock, *Ceram. Abs.*, **13** [9] 230; [11] 283 (1934), is presented. M.V.C.

Reaction between furnace slag and water. F. KAEMPF. *Zement*, **24** [17] 257–62; [18] 272–75; [21] 317–32; [22] 335–39; [25] 381–85; [26] 398–400 (1935).—Although hydraulic properties of blast-furnace slags were discovered in 1862 by E. Langen, knowledge of the chemical reactions during hardening is very limited. This is due to the fact that slag does not harden by itself but requires excitation from a foreign reactive to develop its hydraulic power of hardening. K. availed himself of the T. Wang process to analyze hydration of slags. He used granules of 88 to 120μ, stirred with water or solutions, and decanted, obtaining separately the new chemical compounds. Results may be summarized as follows: (1) As well known in practice, pure water does not swell slag grains or form new bodies in noticeable amount. (2) Excitation by alkali is due to binding of $Ca(OH)_2$; that by sulfate results from binding of $CaSO_4$ with slag. (3) Attack of "excitors" acts principally on aluminates of slag. Alkali causes formation of calcium alumina hydrates; sulfate, that of calcium alumina sulfate hydrate. This explains why slags with small alumina content possess such a small hydraulic power. (4) Hydration of silicates gives calcium silica hydrates, the molecular quotient between lime and silica being 1.0 to 1.5. This was recently confirmed by other research in the Berlin Univ. Inst. (5) In comparison with Portland cement, concentration of $Ca(OH)_2$ in the liquid phase is much smaller. This is due to binding of lime by slag and also to the influence of variable quantities of sulfide on solution equilibrium. (6 and 7) The part played by sulfur (included in slag) is beyond expectation. This sulfur is present in slag as CaS, a very small percentage being free sulfur. (8) Calcium

sulfide is favorable to hydration, its hydrolitic decomposition giving calcium hydrosulfide and calcium hydroxide; the last named is an excitor. (9) Free sulfur reacts with dissolved calcium sulfide and forms polysulfide; it reacts also with dissolved calcium hydroxide and forms thiosulfate. Polysulfide in presence of calcium hydroxide also becomes thiosulfate. This means dispersion of lime and impediment of hydration. (10) For this reason, care must be taken that sufficient lime be available, the atomic proportion of sulfur to lime, in liquid phase, being not more than 2:1. (11) The presence of sulfur in new bodies makes likely the existence of a complex calcium alumina sulfide hydrate due to juxtaposition of calcium sulfide and calcium alumina hydrate. (12) During experiments, a peculiar phenomenon was observed. At first there was an intense interaction with formation of a gel layer on slag granules. This layer slackens chemical action until the layer is mechanically repulsed. Then the phenomenon begins anew. (13) If sufficient lime is present, hydration of slag gives the same silica and alumina hydrates as in hydration of Portland cement. F.E.V.

Structural brick from waste in the production of magnesite. V. V. Belovodskiĭ and N. A. Golushko. *Ogneuporui*, **3** [4] 256–60 (1935).—Waste dust obtained in the rotating tubular kilns for burning metallurgical magnesite (about 10% of the total output) possesses properties approximating those of caustic magnesite. By working it up with a solution of $MgCl_2$ and molding with a filler (gas-producer slag, quartzite, etc.) a good brick was obtained that can be used for industrial structural work. The production process is described, and data on raw materials and finished brick are given. P.B. & E.S.

Value of waterproofing compounds for impermeability of concretes. Edmond Marcotte. *Génie Civil*, **105** [14] 309–12 (1935).—Tests for determining the quality of waterproofing compounds are given. Several compounds were investigated: $CaCl_2$, $CaCl_2$ with the admixture of greases and similar compounds, soaps, soaps in combination with slaked lime, powders, and similar substances. Pronounced impermeability is usually observed after their addition, but this property decreases a great deal in practically all cases when the concrete is dry. J.D.G.

BULLETIN

Quaternary System CaO–Al_2O_3–SiO_2–Fe_2O_3 in Relation to Cement Technology. F. M. Lea and T. W. Parker. *Dept. Sci. Ind. Research, Tech. Paper* No. 16 (1935). vii + 52 pp. Price 1s. The applications of the results of an investigation on the system CaO–$2CaO{\cdot}SiO_2$–$5CaO{\cdot}3Al_2O_3$–$4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$ to the study of Portland cement is discussed. The results confirm the conclusions previously drawn from the study of the ternary system regarding the constitution of Portland cement. The compounds formed are $3CaO{\cdot}SiO_2$, $2CaO{\cdot}SiO_2$, $3CaO{\cdot}Al_2O_3$, and $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$, together with small amounts of free CaO or of $5CaO{\cdot}3Al_2O_3$. The calculation of the compound contents of Portland cements from the analytical composition is considered in relation to the equilibrium existing in the cement clinker at the clinkering temperature. The errors which arise in the calculated compound content, due to the failure of the liquid present at the clinkering temperature to maintain equilibrium with the pre-existing solid on cooling, are considered. The maximum amount of lime which can be combined in a Portland cement under clinkering conditions is discussed. In order that free CaO shall not exist in the solid in equilibrium with the liquid at the clinkering temperature, it is necessary that the total lime shall not be in excess of that given in the formula $CaO = 2.80SiO_2 + 1.18Al_2O_3 + 0.65Fe_2O_3$. The proportion of liquid formed at various firing temperatures is calculated for some mixes of lime, alumina, silica, and ferric oxide of Portland cement composition and the results are shown to agree with experimental counts on thin sections of the clinkers fired at these temperatures. Experimental counts on thin sections of well-fired commercial Portland cement clinkers show that from 25 to 30% liquid was formed at the clinkering temperature. In the less well-fired clinkers the proportion is lower. It is shown that conditions of firing vary so widely that no relation exists between the free-lime content and the amount of liquid formed at 1400° but that under commercial conditions the clinkering of the cements in which less than 22% liquid is formed at 1400°, to yield a product with a low free lime content, is difficult. The relation of the total lime content of the mix together with the 1400° liquid content to the free lime content is also discussed. See also "Investigations—" *Ceram. Abs.*, **14** [7] 173–74 (1935).

H. E. Simpson

PATENTS

Arsenate aluminate cement and method for its production. Bolidens Gruvaktiebolag. Brit. 435,015, Sept. 25, 1935 (Feb. 19, 1934).

Cementitious material. C. K. Roos (United States Gypsum Co.). U. S. 2,017,022, Oct. 8, 1935 (Aug. 20, 1924). A process of forming a cellular cement comprises forming a tenacious foam and mixing the foam with a cement.

Enamel

Accounting for porcelain enameled products: III. Charles S. Pearce. *Enamelist*, **13** [1] 9–10 (1935).—Mill-room cost should be applied to the particular order, if it is job shop work, or to the cost of the enamel itself, if it is used in a production. Methods are described. For previous parts see *Ceram. Abs.*, **13** [3] 54 (1934). E.J.V.

Air-condition graining room; card system checks spraying. Geo. D. Roper Corp. *Ceram. Ind.*, **24** [5] 282–84 (1935).—Controlled atmospheric condition in the graining room and the use of an easy-handling graining machine developed by J. B. Smith result in greater ease of operation, uniformity of product, and increased production of grained enamel. Use of the silk-screen process to replace decalcomania in printing the nameplate and stock operating instruction has cut the cost of printing. A card system for recording the quality of spraying done by each operator daily helps cut down the percentage of rework as the worker strives to keep up to the spraying standards set up by the plant. Illustrated. E.J.V.

Automatic welding of food compartments. H. Thomas-

SON. *Can. Machinery & Mfg.*, **46** [8] 37–38 (1935).—Flexarc welder with a.c. of 100 to 125 amp. and superimposed high-frequency current is used. The high-frequency current carries the arc over the zero voltage part of the a.-c. cycle. With this arrangement the a.-c. arc is preferred to d.-c. because of entire elimination of arc blow and because of higher welding speeds, sounder welds, and more economical welding. A less skilful operator is required. Heavy-coated $^1/_8$-in. electrodes, principally gas-shielded, are used which leave little slag. The rods with heavy slag-producing coatings led to entrapped slag in the weld which caused enameling troubles. Preparation for enameling consists of sandblasting welds and bosses and pickling the entire compartment, followed by a vitreous black ground coat and two white coats, the last coat being acid resisting. The new method has reduced enameling rejects from 10% to less than 1% because of absence in welds of nonmetallics and gas. W.H.B.

Cast-iron stoves. O. KEMPFE. *Glashütte*, **65** [15] 239–41 (1935).—The composition of cast iron used for enameled stoves is discussed. Parts of the stove subjected to fire should contain graphite in a finely distributed form which is obtained by selecting suitable raw iron and a low carbon content. A 1.5% content of phosphorus hinders the disintegration of iron carbide. The composition of enamels used is mentioned. M.V.C.

Ceric oxide as opacifier. JOHANNES LÖFFLER. *Emailwaren-Ind.*, **12** [33] 265–67 (1935).—An opacification of sheet-iron enamel by saturation with cerium dioxide is practically impossible; at best, a saturation is obtained with cerium silicate whose opacification effect is much weaker than that of the dioxide. By means of a special treatment, cerium dioxide can be transformed into a form which is quite resistant to the solving action of the enamel. Two per cent cerium dioxide added to the mill to opacify a "normal" sheet-iron enamel has the same effect as 5% tin oxide. The loss in opacification resulting from the dissolving of ceric oxide is compensated for by the gas opacification which is produced by this dissolving. M.V.C.

Cerium as enamel raw material. L. KAMP. *Glashütte*, **65** [32] 488–90 (1935).—Experiments showed that ceric oxide does not improve the acid stability and opacification of enamel. The opacification is diminished when replacing cryolite by ceric oxide, but the latter improves the luster of the enamel. Opacification by means of the mill is a gas opacification and requires definite treatment and recipes to obtain maximum effects. Ceric oxide can not play an important rôle in the enamel industry because of its cost. M.V.C.

Cerium and zirconium oxide for enameling cast-iron bath tubs. ANON. *Sprechsaal*, **68** [31] 482–83 (1935).—The preparation of cast iron for enameling is discussed in detail. The composition of the borosilicate frit depends on the nature of the cast iron. The same is true of the granulation and viscosity of the enamel slip which are determined experimentally. The enamel is fired at 830 to 850° for 12 or 15 min. The enamel containing cerium oxide is white, opaque, and semilustrous after cooling. It is applied wet or powdered. Zirconium yields an opaque, lustrous, refractive enamel. The frit should not contain much borax. The wet and powder methods of applying the enamel are described. M.V.C.

Cleaning in enameling. R. ALDINGER. *Glashütte*, **65** [29] 438–41 (1935).—Lighter sheet-iron pieces are prepared for enameling first by heating and then by cleaning in hydrochloric or sulfuric acid. The heating is sometimes omitted. Heavy pieces are cleaned by sandblast. Many defects ascribed to cleaning are in reality caused by insufficient burning and it is noted that oils do not burn regularly, but coke instead. Therefore burning should be done in such a way that not only the surface greases are removed by combustion, but also the oils which penetrate the pores of the metal. Cleaning installations and conditions for firing, cleansing, rinsing, and neutralization are discussed. M.V.C.

Color oxides for enamels. MAX PAQUET. *Emaillerie*, **3** [7] 13–17 (1935).—P. gives the basic formulas of the blue, blue-green, and green colors for enamels, methods of fabrication, and uses in enamels. M.D.

Common defects in the vitreous enameling of sheet iron, C.R.C.A. steel, and cast iron. C. P. STONE. *Sheet Metal Ind.* [London], **9** [102] 633–42 (1935).—The control of sheet-iron and steel enameling to avoid defects should include (1) coöperation with the sheet-metal department in design of parts suitable for successful enameling, (2) examination of the parts for buckles, burrs, fractures, and contamination, (3) control of acid, alkali, and water tanks and, after pickling, examination of the parts for black specks and patches, (4) grinding of the enamel ground coat to the correct number of units and its use at a practical consistency with good sieving arrangements, (5) use of asbestos gloves only and careful handling for the firing of ground coats, (6) examination of the ground coat for defects, (7) application of the cover-coat enamels at 45 lb. pressure to avoid ripply surfaces, dry spraying, and thin edges, (8) use of clean and hot bars, with fusing at sight for cover enamels. For cast-iron work (1) the castings should be free from heavy lugs, and quirks in ornamental moldings should be eliminated; (2) annealing should be carried out in a special furnace in the blasting department; (3) an examination of the castings should be made before blasting; (4) the pressure of the air for blasting should be 70 lb. at the nozzle, and a further examination of the parts must be made after this operation; (5) all holes should be filled with a good stopping before spraying; (6) the enamel should be applied at 50 lb. pressure and dried at 160°F; and (7) a firing clock should be used to indicate when the load is ready to be withdrawn. G.H.A.

Composition of enamels. L. VIELHABER. *Emaillerie*, **3** [7] 21–23 (1935).—V. gives color additions to be fused with powder majolica enamels and a formula of low lead-content powder majolica enamel. M.D.

Controlling dry sand strength. H. W. DIETERT AND F. VALTIER. *Foundry*, **62** [12] 24–56 (1934).—The use of various types of clays as bonds for foundry molding sands is described in detail. Illustrated. F.G.H.

Deënameling defectively finished wash tubs. F. L. PRENTISS. Abstracted in *Sheet Metal Ind.* [London], **9** [100] 507 (1935). G.H.A.

Defective sheet steel as a reason for defective coats on galvanized and enameled ware. H. FROMME. *Forschungsarb. Metallkunde & Röntgenmetallographie*, Series

11, pp. 10–24 (1934); abstracted in *Referat. Silikatliteratur*, No. 1102 (1935).—The properties, composition, and working of sheet steel are discussed. M.V.C.

Determination of heat conductivity of enamels. W. A. DAWIHL. *Chem. Fabrik*, **8**, 327–29 (1935).—Information regarding the heat conductivity of enamels used for technical apparatus is desirable. Measurements were made on enameled sheet-iron cups 8 cm. in diameter and 12 cm. high. The heat conductivity depends largely on (1) fired structure of enamel (pore space) and (2) chemical composition. The former had a greater influence, as it was found that enamels of identical composition, but treated and fired differently, gave different readings. It was impossible to lay down factors for calculating the heat conductivity of enamels from their chemical composition, but from a large number of enamels used for kitchen ware an average value of 0.0027 at 40°C was found. L.E.T.

Determining the grinding fineness of enamel. HANS HADWIGER. *Glashütte*, **64** [37] 616–18; [38] 629–31 (1934).—Methods for determining the fineness of enamel and experiments with the sifting of various enamel ground coats are described. The results are shown in curves and tables. M.V.C.

Economy in material and costs of spraying enamel slip with a pistol over other coating methods. WILHELM. *Sprechsaal*, **68** [18] 273–74 (1935). M.V.C.

Effect of metal oxides on acid stability of enamel. HANS HADWIGER. *Glashütte*, **65** [30] 453–55 (1935).—Acid stability of enamel decreases with the introduction of metal oxides, such as Cr, Co, Cu, V, Mn, and Zn, regardless of whether they are added to the melt or mill. The solubility-residue curves obtained by treating the enamel in various acids show that the effect of separate metal oxides is different. M.V.C.

Effect of treatment of melts by slags rich in ferrous oxide and acid slags poor in ferrous oxide on the crystallization and mechanical properties of gray cast iron. P. BARDENHEUER AND A. REINHARDT. *Mitt. Kaiser-Wilhelm Inst. Eisenforschung Düsseldorf*, **16** [6] 65–75 (1934).—The influence of slag composition on the chemical composition, including O and other gases, bending strength and deflection, tensile strength, and Brinell hardness of cast iron has been determined. With a slag high in FeO, solidification takes place in all melts without undercooling and with the appearance of graphite; with acid slags low in FeO, undercooling occurs. A low FeO slag reduces the bending and tensile strength of low carbon steel. The reduction becomes less as carbon content increases until at 3.4% C it disappears. Above 3.4% C both strengths are increased. Hardness was not influenced by the slag. Changes in silicon content of the melt change the response to slag treatment in most cases. J.B.A.

Electric kilns in enamel mills. CASTNER. *Emailwaren-Ind.*, **12** [30] 241–43 (1935).—A brief review of small electric kilns used in enamel mills is given. M.V.C.

Electric pickling. A. E. CHESTER AND J. C. KRISTER. *Emaillerie*, **3** [5] 5; [7] 8–12 (1935).—The "Ferrolite Pickling System," a method of electric pickling, is described. M.D.

Enamel pigments. L. STUCKERT. *Glashütte*, **65** [9] 139–40 (1935).—A review of recent investigations on enamel pigments, their treatment, and effect in enamels is described. References are given. M.V.C.

Enamel technique in the U.S. W. OBST. *Emailwaren-Ind.*, **12** [22] 178–79 (1935).—A brief review is given of the latest researches in the U.S. on the adherence of enamel. M.V.C.

Enamel thickness gage. M. A. RUSHER. *Bull. Amer. Ceram. Soc.*, **14** [11] 365–67 (1935); *Ceram. Ind.*, **25** [4] 225–26 (1935).

Enameled cast-iron versus enameled sheet-metal plumbing fixtures. A. P. WOOLFOLK. *Ceram. Age*, **23** [4] 114–16 (1934).—Enameled cast iron and enameled sheet steel for plumbing fixtures are compared with respect to cost of manufacture, appearance, and serviceability. From the standpoint of cost, there is little difference between the two, although greater flexibility is possible in the production of enameled cast iron. In appearance there is little choice, but from the standpoint of service, enameled cast iron is definitely better because the greater strength and rigidity of the cast-iron body protects the enamel from physical shock. The greater amount of enamel on cast-iron fixtures also gives longer wear. F.G.H.

Enameled ornamental ware. VIELHABER. *Emailwaren-Ind.*, **12** [24] 196–97 (1935).—The use of enamel for ornamental ware, mostly of copper or German silver, is briefly dealt with. M.V.C.

Enameling cast iron. L. VIELHABER. *Emaillerie*, **3** [7] 5–7 (1935).—To prevent the formation of pinholes, dried milled enamel is powdered over the wet coating of liquid enamel previously applied as usual. Results are said to be good but the coating is thicker and looks like powder enameling. See also *Ceram. Abs.*, **14** [3] 62 (1935). M.D.

Enameling cast-iron hearths. H. J. KARMAUS. *Sprechsaal*, **67** [38] 577–79 (1934); abstracted in *Referat. Silikatliteratur*, No. 1019 (1934).—The enameling of cast-iron hearths for heating rooms with wood or coal is discussed in detail. Enamel compositions are analyzed and directions for applying are given. M.V.C.

Enameling plant lay-out and production. J. T. GRAY. *Sheet Metal Ind.* [London], **9** [95] 161–63; [96] 217–18; [97] 319–22 (1935).—In British plants, completely mechanized processes have not replaced the batch type to the same extent as in America, and at present it is felt that the capital outlay does not justify the change. The reverberatory type of smelter, however, has given way to the oil-fired, rotary kiln. A comparison is given of the operation of the two types:

	Rotary Type	Reverberatory Type
Internal dimensions	6 ft. x 27 in. diam.	5 ft. 6 in. x 4 ft. 10 in.
Frit output	500 lb.	1700 lb.
Average smelting time	3 hr.	8 hr.
Oil consumption per ton of frit	96 gal.	105 gal.

For dry grinding, either porcelain balls or "rocks" of enamel are used and Silex blocks for mill linings. The Coupe dusting booth is described. Magnetic separators for enamel slip prevent the formation of black specks on the finished ware. The operation of a vibrating sieve

which does not separate the water from the solid material is described. The pickling equipment comprises degreasing, acid, water, soda, and borax tanks and a conveyer drier. Details are given of both stationary- and conveyer-type ovens for drying biscuit ware. Oil-fired fusing furnaces served by double-acting charging machines are used. A plan shows the suggested lay-out of a plant producing sheet-iron enameled ware. Illustrated. G.H.A.

Foundry sands. T. R. STANLEY. *Can. Mining Met. Bull.*, No. 281, pp. 391–96 (1935).—General properties of foundry sands and some tests on Canadian and American sands are given. G.M.H.

Fused ground on cast iron. VIELHABER. *Emailwaren-Ind.*, **12** [28] 226–27 (1935).—The use of larger amounts of borax in ground enamel to promote adherence is discussed. M.V.C.

Gray and cloudy enamels. VIELHABER. *Emailwaren-Ind.*, **12** [26] 211 (1935).—Decorations that were used a long time ago are again coming back into style. The processes that were formerly used are reviewed. It is possible to create white spots on a blue, brown, or black ground by the addition of cryolite to the mill or by using a spraying pistol. At the time of application and drying, nothing abnormal is noticed; the spots appear during firing. Another process consists in forming clouds in the enamel, *e.g.*, by applying at the same time the mass and an enamel of the same composition in which nickel and cobalt are replaced by antimony oxide, leuconine, or another antimonate. M.V.C.

Improving surface quality of castings. A. KARSTEN. *Giesserei*, **22** [17] 411–12 (1935).—Instead of welding on to the surface layers of hard materials, which is always difficult to do neatly and with uniform denseness, a modified spraying process is described by which wear-resistant surfaces can be obtained. Alloy steels are volatilized in the spraying pistol at the proper temperatures and sprayed on to the surface where they adhere perfectly. This process has proved to be equal to the building-up method by the arc and gives dense, uniformly hard layers. Examples of various applications are described. M.H.

Laboratory control in dry-process enameling. R. D. COOKE. *Bull. Amer. Ceram. Soc.*, **14** [11] 373–74 (1935).

Larger amounts of clay in the enamel batch. VIELHABER. *Emailwaren-Ind.*, **12** [26] 209–10 (1935).—It is quite possible to replace a part of feldspar by clay in some enamels. Clay melts less easily than feldspar and the enamels containing it require a longer time to be melted. Colored clays melt more easily than white clays because their impurities act as fluxes. The amount of clay used depends chiefly on the purpose for which the enamel will be used. See "Clay—" *Ceram. Abs.*, **14** [1] 4 (1935). M.V.C.

Luster and opacity of enamel. VIELHABER. *Emailwaren-Ind.*, **12** [22] 177–78 (1935).—Difficulties encountered when comparing the luster, opacity, and color of enamels and means of avoiding them are briefly discussed. M.V.C.

Magnetic separation of iron from raw enamel. VIELHABER. *Emailwaren-Ind.*, **12** [21] 169–71 (1935).—The effect of iron present in enamel raw materials on the enamel and methods used for its magnetic separation according to French and American technical literature are discussed. M.V.C.

Majolica enamel, its composition and production. M. SIEBERT. *Glashütte*, **65** [4] 52–55; [18] 283–85; [21] 323–26 (1935).—Seven methods used in majolica enameling, compositions of a series of enamels, and their production are described in detail. M.V.C.

Method for bright-pickling metals. W. HEIMBERGER. *Oberflächentech.*, **12** [19] 238 (1935).—Instead of the usually employed sulfuric and hydrochloric acids of more than 10% concentration, Ger. Pat. 618,614 uses salts of the magnesium, earth-alkali, and alkali groups, including aluminum, together with mineral acids. The following solutions give good results for iron: hydrochloric acid 1% + magnesium sulfate 2%, hydrochloric acid 1% + sodium nitrate 2%, sulfuric acid 1% + potassium nitrate 2%, and potassium persulfate 4% + sodium nitrate 2%. Mixtures of these liquids may also be used. The best pickling temperature is 80°C. If the material is very rusty or scaly, a preliminary pickling in 2% sulfuric acid + 2% potassium nitrate at 70° is recommended with subsequent pickling in ¼% sulfuric acid + 2% potassium nitrate at 80°C for 1 min. This will produce a metallically pure surface. Neutralizing as in other pickling methods is not necessary; rinsing in water is quite sufficient. Nonferrous metals and their alloys, *e.g.*, Cu and brass, may also be pickled in these solutions in preparation for painting, galvanizing, or enameling. M.H.

Method for testing adherence of ground coats to metal. C. J. KINZIE AND J. B. MILLER. *Bull. Amer. Ceram. Soc.*, **14** [11] 371–73 (1935).

Mill additions of 20 to 35% clay for sheet-iron ground enamels. FRITZ FIEBIG. *Emailwaren-Ind.*, **12** [16] 132–33 (1935).—By using special clay from Westerwald it has been possible to add 20% clay to the mill. The compositions of the batch and clay and details of the experiments are described. The following advantages were obtained: (1) a thinner and more rapid coating, (2) increased impact strength and elasticity, and (3) lower cost of production. M.V.C.

Minimum radius of curvature for enameled parts. H. H. HOLSCHER. *Bull. Amer. Ceram. Soc.*, **14** [11] 369–71 (1935).

One cover-coat enamel finishes. F. R. PORTER AND G. L. BRYANT. *Bull. Amer. Ceram. Soc.*, **14** [11] 367–69 (1935).

Porcelain enamel cleaner. FRANK J. ZVANUT. *Enamelist*, **13** [1] 14–16 (1935).—Results of an investigation of eight cleansing powders as to grit content, scratching power, and solubility are presented. The harmful effect of the continued use of common kitchen scouring powders on the lustrous finish of porcelain enameled ware is pointed out. Illustrated. E.J.V.

Porcelain enamel as lining for steel tanks. HARRY E. MARTIN. *Enamelist*, **12** [12] 18–20 (1935).—A brief historical sketch of the Pfaudler Co., with plants at Rochester, N. Y., and Elyria, Ohio, is presented. The development of porcelain enamel-lined steel tanks, using acid-resistant enamels which contain no metals, is described. These tanks are produced in sizes ranging from 5 gal. in capacity to 126 in. in diameter by 20 ft. long. Illustrated. E.J.V.

Porcelain-like enamel on cast iron. HUGO SCHULZE. *Glashütte*, 65 [17] 273–74 (1935).—A brief description is given of various methods, such as the powder, wet, and mixed methods, and the application of porcelain-like cast-iron enamel. M.V.C.

Possibilities and working fields of modern sheet-iron enamel technique. H. LANG. *Glashütte*, 65 [8] 120–22 (1935).—The development and further improvements in sheet-iron enameling, including the composition of enamel, kiln operation, and the properties of sheet iron, are discussed. M.V.C.

Powder enamel for bathtubs. H. J. KARMAUS. *Sprechsaal*, 67 [51] 778–80; [52] 792–97 (1934).—A series of enamels for bathtubs are analyzed, and directions for applying them are given. M.V.C.

Relationship between copperheading and fishscaling. J. E. ROSENBERG. *Ceram. Ind.*, 25 [4] 206–208 (1935).—Fishscaling is due to a lack of bond between the enamel and the steel. Production of sheets with roughened surfaces has helped solve the problem of fishscaling. Copperheading is due to the inability of the enamel to hold in solution the amount of iron which it has dissolved. The oxidation which causes copperheading is localized, similar to pitting in the rusting of iron. Fishscaling, on the other hand, is due to insufficient oxidation. The relation of steel composition, pickling practice, and enamel composition to copperheading is discussed. E.J.V.

Relief enamels. VIELHABER. *Emailwaren-Ind.*, 12 [22] 179–80 (1935).—Directions for obtaining various designs and effects on enameled ware are given and several enamel batches are analyzed. M.V.C.

Researches on enameled ware. VIELHABER. *Emailwaren-Ind.*, 12 [19] 157–58 (1935).—The results of investigations on a series of German, Swedish, and American enameled ware with regard to their impact strength, adherence of ground enamel, and size of blisters are described. M.V.C.

Review of theories on adherence of sheet-steel enamels. M. J. BAHNSEN. *Enamelist*, 12 [12] 16–17 (1935).—Theories regarding adherence of enamel to iron include that of the reduction of the cobalt ion to a lower valence state, the necessity of oxygen, and then the "mechanical bond." The later theories tend to take into account a combination of some of the earlier theories. The various theories expounded by different workers are enumerated. E.J.V.

Revolving furnaces in the enamel industry. E. FRANKEN. *Glashütte*, 65 [13] 212–14; [14] 225–26 (1935).—Oil-fired and gas-fired revolving furnaces and their use in the enamel industry are discussed. Illustrated. M.V.C.

Saving materials in enameling. ANON. *Ill. Z. Blechindustrie*, Nos. 5 and 6 (1935); abstracted in *Glashütte*, 65 [27] 410–11 (1935).—After a thorough explanation of the effect of borax in enamel, a series of experiments is described in which borax was partly replaced by soda, potash, saltpeter, fluorspar, cryolite, sodium fluosilicate, and sodium diphosphate. Details are given. M.V.C.

Setting-up ground-coat enamel for dipping. W. J. BALDWIN. *Sheet Metal Ind.* [London], 9 [101] 580 (1935).—To avoid defects, the enamel remaining on the plates after dipping must be constant in amount and evenly applied. This can only be assured by laboratory control of the temperature, viscosity, specific gravity, and "set" of the enamel slip. The "set" will depend on the dimensions of the pieces to be dipped. Ammonium carbonate is sometimes added as a setting-up agent, but more often thick enamel is used for this purpose. G.H.A.

Shell-shaped removal of loam cores. E. FEIL. *Giesserei*, 22 [17] 401–406 (1935).—Experiments were made to find the best conditions and composition of cores when casting hollow parts, tubes, etc., to remove the core as smoothly and in as large pieces as possible to save time. Loam for the core and finer grained loam for the dressing (blackwash) has proved the best material as it possesses, after the cast is finished, sufficient strength, and dressing and core adhere well together; the latter does not stick to the casting and gives a smooth surface. A certain amount of C in the mass is advantageous for the removal of the core from the casting. The technique of making the core and selecting the constituents is described in full. M.H.

Shrinkage of enameling clay on drying. VIELHABER. *Emailwaren-Ind.*, 12 [18] 146–47 (1935).—There is a close relationship between the clay substance and grinding fineness of the enamel. Coarsely ground enamel may be worked with less clay than finely ground enamel. It is of little use to evaluate the suitability of clay according to its shrinkage on drying or according to the formation of cracks in a dried enamel mass. M.V.C.

Testing enameled ware. VIELHABER. *Emailwaren-Ind.*, 12 [12] 97–99 (1935).—Tests to which enamel paints are subjected by the German State Material Testing Board and their application to the testing of enamels are discussed. M.V.C.

Testing the strength of enamels. VIELHABER. *Emailwaren-Ind.*, 12 [16] 129–30 (1935).—The durability of the enamel coat, or its resistance to wear and splitting, is one of the most valuable properties of enameled ware and depends mainly on the hardness of the enamel surface and its resistance to alkalis which are usually used as cleansing mediums. Hardness tests are discussed briefly. M.V.C.

Timing the operations in smelting plants, particularly in steel mills: I–II. G. SCHMIDT. *Arch. Eisenhüttenwesen*, 9, 63–72, 117–25 (1935). W.M.C.

Ulmer lime as raw material for glazes and enamels. T. U. *Emailwaren-Ind.*, 12 [23] 185–87 (1935).—Ulmer lime is especially suitable for enamels, glazes, and glasses; it consists chiefly of calc-spar. It is composed of 0.34 alumina and silica, 0.039 iron oxide, 55.64 lime, and 0.19% magnesia (loss on ignition, 43.70%; loss on drying at 110°C, 0.04%). When added to the enamel, lime increases its chemical resistivity, especially acid stability; it increases refractoriness and promotes opacification of the enamel by preventing the dissolving of opacifiers in the melt. In majolica enamels it has a less important effect, while in ground enamels for sheet-iron ware, it tends to lower the fusibility of the enamel, preventing overfiring in places. An example for the introduction of lime in an enamel batch for household and cooking utensils is given. The advantages obtained were greater resistance to cooking acids, increased resistance to cooking, and lowered cost of production. M.V.C.

Unmelted ground enamel. C. A. OTTERSBACH. *Glashütte*, 65 [32] 487 (1935).—The separate raw materials,

such as borax, feldspar, quartz, etc., are weighed and ground with a 40% addition of water. The mass is ready to be applied. The firing temperature is 900° which is sufficient to form the enamel with good adherence.

M.V.C.

BOOKS AND BULLETINS

Bethlehem Alloy Steels. BETHLEHEM STEEL CO., Bethlehem, Pa. Illustrated Handbook designated *Catalog* No. 107, 1935. 376 pp. Price $1.00. The purpose of the book is to give engineers, designers, fabricators, and users of Bethlehem products dependable working data on the properties and performance of alloy steels. All pertinent existing data have been brought up to date in this volume.

In its treatment of alloy and special steels, in the form of bars, billets, blooms, and slabs, Bethlehem production facilities and quality control are covered in two brief chapters which precede the six main divisions: (1) grades of steel, (2) steels for specific uses, (3) testing and properties of steel, (4) working of steel, (5) definitions of common terms, and (6) tables and useful information.

Charts of heat colors and temper colors are included. This will prove of value to the steel treaters in the industry. The colors have been reproduced with unusual fidelity and correspond to the actual colors observed on pieces of steel under accurate temperature control. J. C. L.

Proceedings of the Fourth Pennsylvania Mineral Industries Conference. *Penn. State Coll. Mineral Ind. Expt. Sta. Bull.*, No. 18 (May, 1934). 137 pp. Price 50¢. At a joint meeting of the four Pennsylvania chapters of the American Society of Metals, papers were presented on the following subjects: (1) research in the steel industry, (2) habits and laws of decomposition of supercooled solutions with special regard to austenite, (3) P-F characteristic of steel, (4) steels, their selection and application in general shop practice, (5) wrought aluminum alloys for structural applications, and (6) effect of gases on ferrous materials at high temperatures and pressures. Discussions of the various papers are also presented. H. E. SIMPSON

Town gas for vitreous enameling. O. W. ROSKILL. British Commercial Gas Association, London. 12 pp. Free. Reviewed in *Sheet Metal Ind.* [London], 9 [98] 373 (1935).—The application of town gas in the fritting, pickling, degreasing, drying, and fusing operations is discussed. G.H.A.

PATENTS

Ceramic article. W. J. SCOTT (Western Electric Co., Inc.). U. S. 2,020,476, Nov. 12, 1935 (Feb. 17, 1933). A ceramic article comprises a base having a groove in such proximity to an edge thereof as to form a sharp ridge at the edge and a ceramic coating thereon extending to the ridge.

Ceramic article. W. J. SCOTT AND S. R. MASON (Western Electric Co., Inc.). U. S. 2,020,477, Nov. 12, 1935 (Oct. 27, 1933). A method of forming a ceramic article comprises copper plating, a ferrous metal base, nickel plating thereover, and applying an enamel coating over the nickel plate.

Enamelware. OSCAR HOMMEL (Enamelers Guild, Inc.). U. S. 2,019,676, Nov. 5, 1935 (Feb. 7, 1933).

Process and apparatus for enameling or glazing metal. F. M. WIRTZ AND REIMBOLD & STRICK GES. Brit. 434,115, Sept. 11, 1935 (Jan. 18, 1934).

Process for producing enameled iron articles. PHILIPP EYER. U. S. 2,016,322, Oct. 8, 1935 (May 17, 1932). In the process of directly enameling iron articles with a light colored glaze, an improvement comprises melting a mixture of oxide of antimony and of oxide of zinc to produce a fritted product, incorporating the fritted product in a raw glaze, and applying the raw glaze containing the fritted mixture directly to the surface of the iron article to be enameled.

Sign. JAMES BOYCE (Chicago Glass Novelty Corp.). U. S. 2,019,113, Oct. 29, 1935 (Aug. 11, 1933).

Glass

Angular distribution of light from diffusing glasses. E. F. M. VAN DER HELD AND M. MINNAERT. *Physica*, 2 [8] 769–84 (1935).—The angular distribution of transmitted light was determined for several frosted and rippled glasses. The great variety of results for varying conditions of illumination makes complete sets of measurements a practical necessity. C.J.P.

Architect looks at glass and enamel. FRANK MILLS LESCHER. *Ceram. Ind.*, 25 [4] 189 (1935).—After discussing architectural uses of glass, L. suggests the possibilities of using glass as an envelope for electrical lighting and heating panels and the use of heat-absorbing, light-transmitting glass for walls of buildings as a solution of problems confronting air-conditioning engineers. The possibilities of enameling larger panels for use in construction so as to eliminate the outer coverings now required in porcelain-enameled structures are also pointed out.

E.J.V.

Aspect of glass. C. G. HOLME. *Studio* [London], 110, pp. 211–13 (1935).—The part of glass in the interior decoration of modern homes is discussed. The new dining-room of the Euston Hotel, London, suggests the enormous possibilities of luminous columns and walls in the solution of lighting problems in houses of the future. G.H.A.

Carrying out the technical melting process of glass factory operation in the laboratory. H. JEBSEN-MARWEDEL AND A. BECKER. *Glastech. Ber.*, 13 [4] 109–13 (1935).—A laboratory method of studying the action of sulfate-carbon mixtures on the gall formation, fusion, color, and fining of a normal soda-lime-silica glass is described. The method agrees accurately with plant practice. The glass studied had the composition 72.5 SiO_2, 0.5 R_2O_3, 0.5 CaO + 14.0 MgO, and 13.0% Na_2O. The amount of soda introduced as sulfate was varied from 1 to 6%. The amount of powdered carbon was varied at the same time from 2.1 to 10.5% of the weight of sulfate added. The melts of 500 g. were made under constant furnace conditions at 1350° under a slightly reducing condition. The bottoms of the crucibles were then cut off and the melts examined by transmitted light from the edge of an illuminated field. They were then classified according to whether the gall formation, complete fusion, and color

were good or bad. The area of good glasses was between 2.6 and 4.3% soda from sulfate and carbon to the extent of 3.3 to 7.0% of the weight of sulfate. G.R.S.

Cause of fluoride opacification in glasses. THÜRNER. *Glashütte*, **65** [24] 359–61 (1935).—Experiments show that different effects of fluoride opacifiers are due to a crystalline opacification and not to a gas opacification. It is improbable that CaF is formed. Fluorite tends to disintegrate and is probably the only fluoride promoting the volatilization of SiO_2 as SiF_4. Sodium fluoride is the most stable salt, and it may be formed in the glass melt. The great number of chemical and technical effects cause the incompleteness of these processes. The practical conclusions are that the stability, rate of reactions, and the amount and kind of newly formed chemical compounds, especially those which produce or promote opacification in the melt, determine the kind of opacification and the permeability to light. The slightly stable fluorides (fluorspar) and those that burn off (sodium fluosilicate) produce a much weaker opacification than the reactive but fluorstable cryolite. The dissolving of pots by fluor-containing melts is a surface phenomenon caused by the contact of two foreign and physically different bodies (molten glass and solid clay); it is to be noted that fluorides disintegrate at the time the melt no longer contains any reagent so that they chiefly attack the refractory materials and the bottom of the pots. Bibliography. M.V.C.

Champagne-yellow glass. EGON ARNOT. *Sprechsaal*, **68** [25] 389–90 (1935).—The production of champagne-yellow flash glass for illuminating purposes is briefly discussed. The manufacture of this type of glass is very delicate as the exact yellow coloring depends chiefly on the conditions of melting and operation, especially when using glass cullet, and not on the composition of the batch. M.V.C.

Controlled luminous gas flame in glassmelting. J. B. NEALEY. *Ceram. Ind*, **24** [5] 273–74 (1935).—Use of the controlled luminous flame method of heating glassmelting tanks has produced ware of greater strength and better appearance. Procedure involves careful proportioning, thorough mixing and uniformity and regularity in charging of the raw materials, and unvarying heat conditions within the furnace, which include uniform flame coverage. Control starts with a metered source of both fuel gas and air for combustion. The control of flame length, next in order, is accomplished by changing the ratio of air to waste gas in the velocity-controlling apparatus. The luminous gas flame has a high emissivity (radiating capacity) and with uniformity of heating and constant combustion conditions improved ware is obtained. Illustrated. E.J.V.

Course in glassmaking. ANON. *Verre & Silicates Ind.*, **6** [15] 280–81 (1935).—In the manufacture of opal glasses, the nature of the opacifiers used and the thermal treatment the glasses receive are important for the degree of opalescence manifest. The diffusion of light by opal glasses is discussed; it depends on (1) the size of the diffusing particles, (2) the difference between the index of refraction of the particles and that of the glass containing them, and (3) the number of particles contained in a unit of volume (1 cc.). *Ibid.*, **6** [17] 319–21 (1935).—Notes on defects in glass due to manufacture are given. See also *Ceram. Abs.*, **14** [11] 272 (1935). M.V.C.

Craft of stained glass. C. PAINE. *Studio* [London], **105**, 297–99 (1933).—An outline of the principles and method of the craft is given with suggestions for its use in the modern house. G.H.A.

Determination of absorption coefficients of filter glasses in the infra-red up to 4.1μ. KARL KAISER. *Glastech. Ber.*, **12** [6] 198–202 (1934).—The glasses tested included a cobalt glass, a blue glass of unknown composition, copper, iron, and didymium glasses, and neutral and dark violet glasses. In almost all cases the colored metallic salts could be recognized from their spectrum. Later the presence of boric acid was detected. The number of materials lying on the basic curve made the question of arrangement interesting. See also "Ultra-red—" *Ceram. Abs.*, **13** [8] 205 (1934). G.R.S.

Development of photographic lenses. W. TAYLOR AND H. W. LEE. *Proc. Phys. Soc.* [London], **47** [260] 502–20 (1935).—The history and development of glass lenses for photographic and telephoto purposes are given. The advances in design in the different types are illustrated and discussed. L.E.T.

Development of the Zotos furnace. G. ZOTOS. *Glashütte*, **65** [13] 207–10 (1935).—The process of glassmelting is briefly discussed, and recent improvements in the Zotos glassmelting furnace are described. M.V.C.

Durability and breaking strength of glass bottles. KENT HELMUT BORCHARD. *Sprechsaal*, **68** [10] 147–49; [11] 165–67 (1935).—New contrivances for testing inner pressure, especially for duration-pressure tests of bottles, are discussed. The results of measurements are strongly affected by the kind of stresses, increase of load, and temperature. M.V.C.

Economical source of selenium in selenium-red glass. B. W. MERWIN. *Ceram. Age*, **23** [5] 137–38 (1934).—Selenium-red glass can be produced with a considerable saving of selenium by introduction of the selenium into the glass batch as zinc selenide. The presence of cadmium sulfide and metallic zinc, thoroughly mixed with the zinc selenide, is essential. Metallic zinc tends to keep the selenium from being oxidized to the dioxide. Yellows and oranges, as well as reds, are obtainable by the use of zinc selenide as the source of selenium. F.G.H.

Effect of the duration of melting on the iron oxide content of glasses. FRANZ BAUER. *Glashütte*, **65** [20] 308–309 (1935).—The melted glass attacks glasspots and dissolves a certain amount of iron present in them which counteracts the effect of decolorizers. Tests with two glasses (the first composed of 75% SiO_2 and 25% B_2O_3, Na_2O, and K_2O and the second containing about 4% Al_2O_3 besides) showed that the iron content of the first type of glass increased by 50%, while the Fe_2O_3 content in the glass containing Al_2O_3 did not increase. M.V.C.

Electrically fired furnaces in the glass industry and their economy: II (*continued*). J. HOROWITZ. *Glashütte*, **65** [23] 347–48; [24] 363–66; [25] 377–80; [26] 392–95 (1935).—Various types of electric annealing furnaces are described in detail. Illustrated. See *Ceram. Abs.*, **14** [7] 159 (1935). M.V.C.

Fluorspar for glassmelting. LUDWIG SPRINGER. *Glashütte*, **65** [26] 391–92 (1935).—Fluorspar may replace

fluxes, especially potash, in a glass batch and can also be used as a decolorizer. Experiments are briefly described. M.V.C.

Glass brick. OWENS-ILLINOIS GLASS CO. *Ceram. Ind.*, **24** [5] 250–51 (1935).—Development of an improved glass block for building purposes, which has stood up under pressures of 72,500 lb. to a single block and which reduces heat flow, deadens sound, transmits and diffuses light, deflects sun glare, and resists fire, is announced. E.J.V.

Glass in the decorative scheme. ANON. *Decorator*, **33** [398] 39–42 (1935).—The use of glass for decorative purposes is traced from the 17th Century. It is useful for creating an illusion of spaciousness and its freedom from porosity and any tendency to craze makes it a valuable material in bathrooms. Decorative effects may be obtained by (1) sandblasting, (2) etching, (3) brilliant-cutting, and (4) metallic deposition. G.H.A.

Glass, an industrial material for the chemical industry. F. H. ZSCHACKE. *Glashütte*, **65** [14] 223–25 (1935).—For domestic purposes and in many instances in the chemical industry, glass can replace base metals to advantage. Many applications in both the organic and inorganic fields are given. M.V.C.

Glassmaking in southern California. ROY E. SWAIN. *Glass Ind.*, **16** [11] 333–38 (1935).—The history of the development of the glass industry in southern California is a history of its men, who overcame many difficulties in building it up. Abundant raw materials for the production of glass are found there. The plants manufacturing various types of glass are enumerated and their histories are briefly sketched. Illustrated. E.J.V.

Glass replaces metals for packing food products. ZSCHACKE. *Glashütte*, **65** [18] 286–87 (1935).—Advantages of using glass packing instead of metal packing for keeping food products are briefly discussed. M.V.C.

Glass of today. J. B. P. ROBINSON. *Studio* [London], **110**, 203–208 (1935).—In design there is absence of all unnecessary ornament. Glass tends to be small, plain, and neat. Its modern popularity is attributed to (1) cheapness, (2) flat-dwelling, (3) cocktail drinking, and (4) popularity of cut-flowers. Colors are faint, single, and suffused throughout the glass. G.H.A.

Grinding and polishing in optics. H. SCHULZ. *Glashütte*, **65** [32] 483–84 (1935). M.V.C.

Influence of heat treatment on the diffusing properties and color of glasses. H. H. BLAU AND C. A. STONE. *Penn. State Coll. Min. Ind. Expt. Sta. Bull.*, No. 14, pp. 85–95 (1933).—Glass is quite unusual in having low electrical and thermal conductivities associated with the relatively high transmissions in and near the visible frequencies. This last property is determined largely by the heat treatment to which the glass is subjected. Diffusion of light in glasses is a function of (1) wave-length of the light emitted by the source, (2) thickness of the glass, (3) absorption coefficient of the glass, (4) values of the indices of refraction of the inclusions and the glassy matrix, (5) character of the inclusions, (6) number of inclusions per unit volume, and (7) the dimensions of the inclusions. The control of the last two factors by the proper heat treatment of various illuminating glasses is shown. The influence of heat treatment on certain colored and tinted glasses is also given. H.E.S.

Inner grinding and breaking strength of incandescent lamp bulbs. ANON. *Glashütte*, **65** [16] 255–56 (1935).—The difference in the breaking strength of incandescent lamp bulbs ground on the inside and on the outside and methods used for etching them are briefly discussed. M.V.C.

Kinetic interpretation of the coloring of glass by X-rays. R. LIVINGSTON AND C. E. NURNBERGER. *Jour. Phys. Chem.*, **39** [7] 1011–19 (1935).—An equation is derived which agrees with observations on the rate of coloring of Pyrex-brand glass by X-ray irradiation. Analogous effects of radium radiation are discussed. C.J.P.

Label strikes back at competition. EUGENE M. WYNNE. *Ceram. Ind.*, **24** [5] 286–88 (1935).—The silk screen and carbon tissue processes of decoration are discussed and described. E.J.V.

Light distribution from opal glass. M. MINNAERT. *Physica*, **2** [4] 363–79 (1935).—The Fresnel reflection factor practically determines the distribution of the light scattered by a thick plate of opal glass, neglecting absorption. When boundary reflections are eliminated by liquid immersion and the glass is illuminated and observed under grazing incidence, the backward distribution is substantially equivalent to that from a single particle. By this method the diameter of the scattering particles is found to be from 0.3 to 0.7μ. C.J.P.

Melting and annealing of glass. J. T. LITTLETON. *Penn. State Coll. Min. Ind. Expt. Sta. Bull.*, No. 14, pp. 28–39 (1933); see also *Ceram. Abs.*, **13** [4] 83 (1934). H.E.S.

Mold calculations. DONALD A. BRIDGES. *Glass. Ind.*, **16** [11] 342–43 (1935).—Formulas and information long needed by the container industry are presented. In calculating mold designs, the factors involved include the displacement, reciprocal, weight, and volume factors. All of these and formulas for determining them are developed. E.J.V.

Neglected glass industry in Utah. WILLIAM J. MATHEWS. *Ceram. Ind.*, **25** [4] 188–89 (1935).—The abundance of raw materials for glass manufacture found in Utah is pointed out. A list of the materials which can be made from the raw materials in the Great Salt Lake Valley indicates that Salt Lake City is a favorable position for a glass plant. The Intermountain Glass Co., Midvale, Utah, began production in March, 1935, and is manufacturing all types of glass in many colors, as well as bottles and containers. The present equipment consists of one 15-ton, end-port, continuous tank and two day tanks, three leers, a press, and equipment for both hand-made and machine-made glassware and containers. Illustrated. E.J.V.

Objective and subjective change of colored lights by colored eyeglasses. E. NOTEBOOM. *Z. Instrumentenk.*, **55** [8] 317–36 (1935).—The physiological principles of the adaptation of the eye to the actual color when looking through a colored glass are explained, and a method is developed which permits determining objectively the color as seen by the eye through the colored glass by means of the color triangle. The experiments show that the majority of colored glasses used in eyeglasses do not change

the subjective impression of color, and that only special, very strongly colored glasses cause a distortion of the color triangle; this may be of practical value in particular cases to protect the eye from injury by blinding light sources. The procedure to calculate the color radiation and its change by the colored glass is described in full, and tables for calculating the sensitivity curve of the colors in the color triangle are given. M.H.

Opaline raw materials of the glass industry and their distinctive luminous effect and glass-forming materials. F. JOCHMANN. *Glashütte*, **65** [1] 5–7 (1935).—Very different raw materials are used to obtain opacified, opaline, and opaque glasses. The difference in white, watery, and milky-opaque effects depends on the opacifiers added to the batch, while the composition of the glass itself is of special importance. Opacity alone is obtained with difficultly soluble compounds such as talc, siliceous magnesia, and calcined alumina. Bone ash and guano do not only opacify the glass but produce an opaline to opaque glass. Fluorspar, cryolite, and sodium fluosilicate give an opaque luminous effect. Opacity in talc or moonstone glasses is a physical process, while in phosphate or cryolite-fluorspar sodium fluosilicate glasses it is a chemical process. Calcium oxide in combination with boric acid produces an opaline or opaque effect. There is no marked difference between the luminous effect in bone-ash glass, pure fluorspar glass, sodium fluosilicate glass, and fluorspar sodium fluosilicate glass. All these glasses show a white, watery opacity, depending on the quantitative addition of the respective materials, but pure cryolite glasses have a deep milky whiteness. The different opacifying effects of fluorides, sometimes milky-white, sometimes watery white, are due to the chemical composition of the various kinds of glasses. M.V.C.

"Orion." ANON. *Decorator*, **34** [401] 39–44 (1935).—Decorations in glass in the new Orient liner are described. The embossed mirrors in the dining-room have been executed by Lynton Lamb. Illustrated. G.H.A.

Particle size and concentration in opal glasses. *Rept. Nat. Phys. Lab.* [London], pp. 96–97 (1933).—Measurements were made to test the theoretical treatment of the diffusing properties of opal glasses. The over-all reflection and transmission factors and the scattering coefficients for a number of glasses were determined, and with an interferometer microscope, the average size and number of the particles in the glasses were found. The chemical constitutions of the particles were identified from their X-ray diffraction spectra, and their refractive indices were computed. For the smallest particles, excellent agreement was obtained between theory and experiment, but with increase of particle size the theoretical size became continuously greater than that found experimentally. See also *Ceram. Abs.*, **12** [4] 147; [12] 418 (1933). G.H.A.

Practical glass cooling. E. S. *Sprechsaal*, **68** [32] 499–500 (1935).—The working of glass before its introduction into annealing furnaces, annealing, and cooling are discussed in detail. M.V.C.

Pressure and draft measurements in glassmelting furnaces. K. METZGER. *Arch. Tech. Mess.*, **5** [50] *T*105–106 (1935).—The correct arrangement of measuring instruments, types used, and methods of measuring gas, air, waste gases, and atmospheres in the furnaces to maintain satisfactory, economical operating conditions are discussed and described in detail. M.H.

Pyrolusite as a decolorizer. ANON. *Glashütte*, **65** [17] 270–71 (1935).—Pyrolusite is a suitable, effective, and cheap decolorizer for some glasses, but it can not be recommended for decolorizing high-grade glasses, even in mixtures with other preparations. Bibliography. M.V.C.

Quantitative determination of the stages of oxidation of selenium in alkali-lime glasses with a low iron content. W. HIRSCH, H. WIEGAND, AND A. DIETZEL. *Sprechsaal*, **68** [24] 373–76 (1935).—A review is given of methods used for the determination of selenium, including the gravimetric, titrimetric, and colorimetric methods. Methods used to determine the various oxidation stages of selenium (selenite, selenate, selenium, selenide), the effect of the HCl concentration on the analysis values, and the effect of iron present in glass on the results of analysis are discussed in detail. Bibliography. M.V.C.

Reduction of hours in English glass industry. G. L. PILKINGTON. *Clay Prod. Jour. Australia*, **2** [10] 1–2 (1935).—Reduction from 48 to 42½ hr. a week at St. Helens, England, has meant an increase in hands employed and in output, while wages have not been reduced. The output value per man-hour increased 11.4%. H.H.S.

Relation between attack on fire clay and the density and fluidity of glasses and slags at high temperatures. K. ENDELL AND C. WENS. *Glastech. Ber.*, **13** [3] 78–86 (1935).—The sphere viscometer of W. Hanlein was used. The density of the six glasses and slags studied decreased steadily with increasing temperature in the low viscosity range. This confirmed Hanlein's results. The attack of glasses and slags on fireclay and silica brick increases with the degree of fluidity and is completely independent of chemical composition of the corroding melt. The removal of dissolved material in the flowing process is dependent also on the specific gravity of the glass and slag since the kinetic energy becomes greater with increasing density at the same viscosity. Both influences of density and fluidity at high temperatures accelerate the concentration equalization between the refractory and glass or slag upon which the disintegration of the refractory depends. A more vigorous attack sets in only beyond a fluidity which corresponds to a dynamic viscosity of 35 c.g.s. units with an average density of 3 or a kinetic viscosity of about 10. The flowing times in the flowing viscometer were used as a measure of relative viscosity and were compared with absolute measurements. The range of measured viscosities lies between 30 to 6000 c.g.s. units. For higher viscosities of about 10^3 to 10^{10} poises, the observation of the collapse of glass cylinders by means of a cathetometer with a micrometer eyepiece was satisfactory. Both procedures are usable in practice with proper adaptation for the simple checking up of viscosities of the technical glasses. G.R.S.

Silk-screen printing on cone surfaces. EUGENE WYNNE. *Ceram. Ind.*, **25** [4] 225 (1935).—In setting up a silk screen to print on cone surfaces, the essential principle involved is to pivot the printing screen at the vertex of the angle formed by the sides of the cone. An arrange-

ment adaptable to various sizes of cone-shaped glassware is described. Illustrated. E.J.V.

Silver as a glass colorizer. L. SPRINGER. *Sprechsaal*, **68** [30] 470–71 (1935).—Experiments with the use of silver as a glass pigment are described. It was found that (1) lime crystal glass is strongly and uniformly colored yellow by silver nitrate and silver chloride. An addition of arsenic and antimony oxide, even in small amounts, prevents the coloring. (2) The so-called normal lead crystal glass is weakly and irregularly colored, with arsenic present or not. A stronger coloring is obtained in a heavy lead crystal, but it is irregular. (3) In lime and lead glasses or mixed glasses, an addition of white tin oxide considerably strengthens the yellow coloring; tin oxide has no effect on the uniformity of coloring. An analysis of some glasses for their silver content is given. M.V.C.

Tank furnace for hollow glassware. R. D. *Verre & Silicates Ind.*, **6** [15] 277–79 (1935).—For the production of ordinary hollow glassware, the tank has long supplanted the pot furnace because of the reduction of firing time, better utilization of the firing surface of the furnace, and continuous operation with three shifts of workers. The effect of iron oxide on glass fused in tank furnaces and the construction of the furnace are dealt with. M.V.C.

Tempered glass. W. KAEMPFFERT. *N. Y. Times, Science*, p. 4 (Sept. 22, 1935).—Glass tempered according to the French process, which has been considerably improved by American engineers, is described. A Toledo plant suggests the use of tempered glass for ships, ovens, kitchen ranges, furnaces, ports, fire screens, diving bells, transparent table tops, and aquariums. M.V.C.

BOOKS

English Glass. W. A. THORPE. A. & C. Black. Price 7s 6d. Reviewed in *Times Lit. Supp.*, **34** [1754] 558 (1935).—Glassmaking in the British Isles from Roman times until today is surveyed. Illustrated. G.H.A.

Hutchinson's Technical and Scientific Encyclopaedia: Terms, Processes, Data, in Pure and Applied Science, Construction and Engineering, the Principal Manufacturing Industries, the Skilled Trades; a Working Bibliography, Naming Three Thousand Book and Other Sources of Information, under Subjects. 3 Vols. Edited by C. F. TWENEY AND I. P. SHIRSHOV. Vol. 2, Direction of Rotation to Hydrogen-ion Concentration. ii + 673–1344 pp. Hutchinson and Co., Ltd., London, 1935. Price 28s. Reviewed in *Nature*, **136** [3431] 166 (1935).—In this volume are 20 pages on glass and glassmaking, 9 on furnaces, 6 on gemstones, 4 on geophysics, etc. J.L.G.

Textbook on Glass Technique (Lehrbuch der Glastechnik). LUDWIG SPRINGER. Glashütte, Dresden, 1935. 148 pp., 65 illustrations. Price 4.40 Rm. Reviewed in *Glashütte*, **65** [14] 229 (1935); *Verre & Silicates Ind.*, **6** [16] 307 (1935); *Sprechsaal*, **68** [28] 452 (1935).—In seven chapters S. gives a concise but clear review of various processes of glass manufacture, beginning with a lucid explanation of the term "glass" and its composition. The chapters deal with raw materials, properties, fuels and furnaces, general details of manufacture, compositions and working of various types of glasses (including machines), and decorative and finishing processes. M.V.C.

PATENTS

Apparatus for:

Casehardening glass. R. A. MILLER AND L. V. BLACK (Pittsburgh Plate Glass Co.). U. S. 2,015,807, Oct. 1, 1935 (Dec. 4, 1934).

Circulating the glass in glass-furnace gathering basins. A. F. MCNISH. U. S. 2,021,013, Nov. 12, 1935 (Aug. 5, 1933).

Feeding sheets of glass onto a conveyer. PILKINGTON BROTHERS, LTD., AND J. GASKELL. Brit. 434,201, Sept. 11, 1935 (Feb. 28, 1934).

Grinding and polishing cylindrical lenses. A. J. HOLMAN. U. S. 2,020,312, Nov. 12, 1935 (Feb. 8, 1930).

Making case hardened glass. L. V. BLACK (Pittsburgh Plate Glass Co.). U. S. 2,019,595, Nov. 5, 1935 (Jan. 10, 1935).

Making flat glass. FREDERICK GELSTHARP AND W. G. KOUPAL (Pittsburgh Plate Glass Co.). U. S. 2,015,791, Oct. 1, 1935 (June 30, 1933; July 7, 1934).

Making sheet glass. J. A. WATT (Pittsburgh Plate Glass Co.). U. S. 2,015,773, Oct. 1, 1935 (June 15, 1934).

Removing plaster from plate-glass tables. H. S. HEICHERT (Pittsburgh Plate Glass Co.). U. S. 2,015,797, Oct. 1, 1935 (Sept. 18, 1934).

Shaping glassware. K. E. PEILER (Hartford-Empire Co.). U. S. 2,017,569, Oct. 15, 1935 (July 9, 1929).

Testing and assorting electric incandescent lamps. GENERAL ELECTRIC CO. U. S. 2,020,964, Nov. 12, 1935 (Dec. 28, 1931).

Transporting sheets of glass. GLACERIES DE LA SAMBRE SOC. ANON. Brit. 435,655, Oct. 9, 1935 (Oct. 2, 1933).

Automatic feed for lens grinding and polishing compounds. I. N. CASSITY. U. S. 2,019,171, Oct. 29, 1935 (Oct. 24, 1934).

Automatic machine for the manufacture of bottles. ETIENNE FÉCHOZ. U. S. 2,020,462, Nov. 12, 1935 (Nov. 4, 1932).

Caked glass wool and its manufacture. J. H. THOMAS (Owens-Illinois Glass Co.). U. S. 2,016,401, Oct. 8, 1935 (March 6, 1933).

Continuous glassmelting tank. E. W. PAXTON AND A. W. SCHMID (Amco, Inc.). U. S. 2,016,945, Oct. 8, 1935 (May 31, 1932).

Edge-grinding apparatus. R. J. LOUVIAUX (Libbey-Owens-Ford Glass Co.). U. S. 2,015,720, Oct. 1, 1935 (Nov. 9, 1931).

Electric glass furnace. JOHN FERGUSON (Fairmount Glass Works, Inc.). U. S. 2,018,884, Oct. 29, 1935 (Nov. 11, 1933).

Electrically heatable spectacle lenses and method of making. C. ZEISS. Brit. 436,132, Oct. 16, 1935 (May 7, 1934).

Fitter or shaper for glass articles. J. C. E. SCHWAB (Hazel-Atlas Glass Co.). U. S. 2,019,736, Nov. 5, 1935 (May 9, 1933).

Furnace tank construction. J. E. MCBURNEY (Owens-Illinois Glass Co.). U. S. 2,016,382, Oct. 8, 1935 (March 10, 1933).

Glass feeder. G. R. Haub. U. S. 2,020,143, Nov. 5, 1935 (July 30, 1932).

Glass-feeding device. J. T. Wood. U. S. 2,015,211, Sept. 24, 1935 (Dec. 1, 1932).

Glass furnace. John Ferguson. U. S. 2,018,886, Oct. 29, 1935 (July 13, 1934).

Glass grinding apparatus. F. B. Waldron (Pilkington Brothers, Ltd.). U. S. 2,019,205, Oct. 29, 1935 (Feb. 8, 1935).

Glassware forming machine. E. G. Bridges (Lynch Corp.), U. S. 2,015,662, Oct. 1, 1935 (Nov. 21, 1929). C. C. Kinker (Owens-Illinois Glass Co.), U. S. 2,016,374, Oct. 8, 1935 (April 19, 1934). Frank O'Neill and C. C. Kinker (Owens-Illinois Glass Co.), U. S. 2,018,030, Oct. 22, 1935 (June 7, 1934). C. B. Shillinger (Owens-Illinois Glass Co.), U. S. 2,016,393, Oct. 8, 1935 (May 23, 1932). L. D. Soubier (Owens-Illinois Glass Co.), U. S. 2,016,398, Oct. 8, 1935 (March 31, 1933).

Glassworking apparatus. August Kadow and W. L. Van Ness (Libbey Glass Mfg. Co.). U. S. 2,020,032, Nov. 5, 1935 (July 3, 1933).

Glassworking implement. R. D. Smith (Corning Glass Works). U. S. 2,018,814, Oct. 29, 1935 (Nov. 21, 1925).

Grinding and abrading disk. E. Offenbacher A.-G. Brit. 435,837, Oct. 9, 1935 (Dec. 28, 1933).

Heating and quenching metals and cutting glass. Electric Furnace Co., Ltd. Brit. 435,343, Oct. 2, 1935 (Aug. 24, 1933).

Laminated glass. American Window Glass Co. Brit. 434,314, Sept. 11, 1935 (Dec. 18, 1933). J. C. Henderson. U. S. 2,016,245, Oct. 1, 1935 (Sept. 14, 1928).

Leers for annealing glassware. Green & Co., Ltd., W. Warren, E. King, Taudevin & Gregson, Ltd., and J. H. Webster. Brit. 435,488, Oct. 2, 1935 (March 24, 1934). O. Maetz. Brit. 434,513, Sept. 18, 1935 (Oct. 11, 1934).

Lens. H. W. Lee (Kapella, Ltd.). U. S. 2,019,985, Nov. 5, 1935 (Dec. 26, 1930).

Machines for:

Molding glass articles. V. E. Hofmann (Owens-Illinois Glass Co.). U. S. 2,018,021, Oct. 22, 1935 (May 31, 1933).

Forming hollow glass articles. A. N. Cramer (Owens-Illinois Glass Co.), U. S. 2,016,362, Oct. 8, 1935 (May 26, 1934). W. H. Watkins and C. C. Kinker (Owens-Illinois Glass Co.), U. S. 2,017,998, Oct. 22, 1935 (May 15, 1934).

Forming necks of glass bottles. H. A. Bateson and G. E. Bateson. Brit. 435,774, Oct. 9, 1935 (April 25, 1934).

Forming tumblers. A. N. Cramer (Owens-Illinois Glass Co.). U. S. 2,016,360, Oct. 8, 1935 (Dec. 6, 1933).

Making tumblers. A. N. Cramer (Owens-Illinois Glass Co.). U. S. 2,016,361, Oct. 8, 1935 (April 3, 1934).

Manufacture of glass. Baker & Co., Inc. Brit. 436,250, Oct. 23, 1935 (Jan. 21, 1933).

Manufacture of glass of high permeability to ultra-violet rays. Chemische Fabrik J. A. Benckiser Ges. and F. Draiseach. Brit. 436,426, Oct. 23, 1935 (Feb. 21, 1934).

Manufacture of laminated decorative glass-surfaced sheet material. E. W. Aldridge. Brit. 435,396, Oct. 2, 1935 (March 16, 1934).

Manufacture of variegated glass articles. H. T. Hellmers and R. H. Donnald (Akro Agate Co.). U. S. 2,019,048, Oct. 29, 1935 (Aug. 29, 1933).

Means for feeding glass to glass-shaping machines. United Glass Bottle Manufacturers, Ltd., and T. C. Moorshead. Brit. 434,639, Sept. 18, 1935 (Jan. 18, 1935).

Mechanism for stenciling glass or other ceramic containers having curved surfaces. H. S. Brickell, Jr. (Hazel-Atlas Glass Co.). U. S. 2,014,373, Sept. 17, 1935 (May 5, 1933).

Method of:

Coating glassware. J. E. McBurney (Owens-Illinois Glass Co.). U. S. 2,016,381, Oct. 8, 1935 (May 4, 1932). A method of applying a sulfur coating to the surface of a molded glass article comprises spraying the surface of the article after it is discharged from the mold and while at a high temperature with a spray consisting of an aqueous solution of sodium sulfate, causing the compound to sublimate when it comes in contact with the hot surface of the article, and then annealing the article.

Controlling current flow in an electric furnace and electrode apparatus therefor. John Ferguson (Fairmount Glass Works, Inc.). U. S. 2,014,615, Sept. 17, 1935 (May 26, 1934). In an electric glass furnace are combined a refractory hearth, a metallic electrode box therein with its upper edges substantially flush with the glass-carrying surface of the hearth, means for maintaining the edges of the box at a temperature below that of the glass material on the hearth, and electrode material contained in the box.

Forming glass articles. August Kadow (Libbey Glass Mfg. Co.). U. S. 2,020,031, Nov. 5, 1935 (July 3, 1933).

Forming glassware. D. E. Gray and W. C. Weber (Corning Glass Works). U. S. 2,015,219, Sept. 24, 1935 (May 31, 1934).

Making molded articles. R. E. Swain. U. S. 2,020,590, Nov. 12, 1935 (Oct. 7, 1932).

Marvering glass and apparatus therefor. Thomas Stenhouse (Hazel-Atlas Glass Co.). U. S. 2,020,623, Nov. 12, 1935 (July 11, 1932).

Method and apparatus for:

Manufacture of safety glass. Jean Haas (Soc. générale d'optique soc. anon. des anciens établissements Huet & Cie and J. Flammarion). U. S. 2,020,178, Nov. 5, 1935 (Dec. 15, 1933).

Melting material in an electric furnace. John Ferguson (Fairmount Glass Works, Inc.). U. S. 2,018,883, October 29, 1935 (Nov. 2, 1933).

Mixing and discharging the contents of an electric glass furnace. John Ferguson. U. S. 2,018,885, Oct. 29, 1935 (June 29, 1934).

Producing nonsplintering laminated glass. A. KÄMPFER. Brit. 434,640, Sept. 18, 1935 (Jan. 23, 1934).

Sealing vitreous bodies. A. R. KNOEPPEL (General Electric Vapor Lamp Co.). U. S. 2,020,729, Nov. 12, 1935 (Jan. 27, 1934).

Stenciling glass or other ceramic containers having curved surfaces. H. S. BRICKELL, JR. (Hazel-Atlas Glass Co.). U. S. 2,014,372, Sept. 17, 1935 (May 4, 1933).

Method and means for circulating glass in glass-furnace gathering basins or forehearths. UNITED GLASS BOTTLE MANUFACTURERS, LTD., AND T. C. MOORSHEAD. Brit. 436,271, Oct. 23, 1935 (Feb. 12, 1935).

Method and means for finishing siliceous articles. GASTON DELPECH (Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey). U. S. 2,018,056, Oct. 22, 1935 (July 6, 1933). A method of treating siliceous articles comprises grinding the surfaces of a hot siliceous article, the surfaces being maintained at a temperature which is at least equal to the transformation point of cristobalite, heating the ground surfaces while they are maintained at the temperature to glaze them, and then reheating the article.

Method and means for fitting caps to glass tubes. J. DICHTER. Brit. 436,618, Oct. 30, 1935 (Dec. 23, 1933).

Method and means of manufacturing hollow articles. GASTON DELPECH (Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey). U. S. 2,019,046, Oct. 29, 1935 (July 6, 1933).

Mold for use on glass-forming machines. F. A. HARRISON (United Glass Bottle Manufacturers, Ltd.). U. S. 2,018,785, Oct. 29, 1935 (March 4, 1935).

Ophthalmic lens. NATHANIEL SINGER (Optical Research Corp.). U. S. 2,015,241, Sept. 24, 1935 (July 18, 1933; May 6, 1935).

Port structure for furnaces. G. W. BATCHELL. U. S. 2,020,760, Nov. 12, 1935 (May 7, 1935).

Process and apparatus for tempering glass. PILKINGTON BROTHERS, LTD., AND J. WILSON. Brit. 435,812, Oct. 9, 1935 (March 29, 1934).

Process for coloring etchings on glassware. N. H. MAGEE AND J. A. PATTERSON, JR. (John M. Maris Co.). U. S. 2,015,903, Oct. 1, 1935 (Dec. 22, 1931).

Process for frosting glass bulbs for incandescent lamps. YUKITOSHI SAKAKURA. U. S. 2,017,733, Oct. 15, 1935 (May 5, 1933).

Process for frosting glass bulbs in gradation. YUKITOSHI SAKAKURA. U. S. 2,018,422, Oct. 22, 1935 (Aug. 29, 1932).

Production of glass. ERICH HEINZ. U. S. 2,020,467, Nov. 12, 1935 (Feb. 8, 1933). In the process of compounding glasses of the usual soda-lime type, a step comprises adding to the usual glass batch ingredients a prefused barium borosilicate flux having a composition which comprises about 8 to 20% by weight boron trioxide and about 15 to 30% by weight barium oxide and containing silica in proportions at least chemically equivalent to the boron trioxide and the barium oxide.

Production of glass vessels having extended narrow necks. J. DICHTER. Brit. 435,678, Oct. 9, 1935 (Jan. 26, 1934).

Rolling glass sheets. N. V. MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Brit. 434,992, Sept. 25, 1935 (Aug. 3, 1933).

Sheet-glass cutting apparatus. J. P. CROWLEY AND NESTOR MAMBOURG (Libbey-Owens-Ford Glass Co.). U. S. 2,019,175, Oct. 29, 1935 (Oct. 12, 1932).

Sheet-glass inspection apparatus. E. A. ROSIN AND A. H. STEBBINS (Libbey-Owens-Ford Glass Co.). U. S. 2,015,730, Oct. 1, 1935 (Oct. 15, 1931).

Safety glass and its manufacture. W. H. SIMMONS, H. TIMMS, AND PLASTIC SAFEGLASS SYNDICATE, LTD. Brit. 434,229, Sept. 11, 1935 (May 15, 1934).

Soft glass composition of high electrical resistance. W. C. TAYLOR (Corning Glass Works). U. S. 2,018,816, Oct. 29, 1935 (Oct. 23, 1933). A glass of high electrical resistance contains lead oxide and also boric oxide and fluorine in combined amount not greater than 6% or less than 1%, the boric oxide content being at least as great as the fluorine content. U. S. 2,018,817, Oct. 29, 1935 (Oct. 23, 1933). A glass of high electrical resistance contains 53 to 60% silica, 18 to 30% lead oxide, 8 to 10% potassium oxide, 2.7 to 3.5% sodium oxide, 0.1 to 1.2% lithium oxide, and aluminum oxide amounting to not more than 2%.

Store-front construction. A. H. STEVENS (Pittsburgh Plate Glass Co.). Brit. 435,016, Sept. 25, 1935 (Feb. 18, 1935).

Tempering plates or sheets of glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 434,331, Sept. 11, 1935 (Feb. 17, 1934).

Tools for cutting glass. GENERAL ELECTRIC CO., LTD., AND J. H. PARTRIDGE. Brit. 436,017, Oct. 16, 1935 (May 18, 1934).

Structural Clay Products

Bituminous mastic for bed course. P. E. SUNDSTROM. *Proc. Nat. Paving Brick Assn.*, p. 7 (1935).—In an effort to produce a more satisfactory bed course for paving brick when laid over badly worn concrete roads, specifications for a new bituminous mastic were recommended. The mastic used now is usually so weak and thin bodied that it does not satisfactorily bridge the cracks present in the concrete, and the moisture present in the concrete easily disintegrates the mastic. The bitumen content is usually so low that the sand grains present in the mastic are covered only with a very thin coating which is not sufficient to prevent the sand from separating out and working down into the cracks, leaving the mobile and unstable mastic under the brick. It is recommended that only the best grades of material be selected and that the proper proportions, kept within certain limits, be used. The method of applying the cushion should be checked very closely. M.C.S.

Brick for city streets and interurban highways: I. H. C. MCCLURE. *Dependable Highways*, No. 117, p. 3 (1931).—Brick roads can be satisfactory only if given the proper foundation with adequate drainage. Due to the

present day high-speed and heavy-laden traffic the foundations required for brick roads are being so designed that the maximum loads to be carried will be more uniformly distributed over a larger area. Increasing the thickness of the edge of the foundation, doweling and dovetailing the joints, and placing reinforcements along the edges and over areas which apparently need such additional precautions are some of the measures being taken. **II.** *Ibid.*, No. 118, p. 3 (1931).—The selection of the proper cushion material requires serious consideration. This material can be sand, lean cement-sand, limestone screenings, or granulated slag; it must pack readily under the roller and lock itself in place after the brick have been placed and rolled. Such a cushion should not be more than $^{3}/_{4}$ to 1 in. thick. The brick used are, in the majority of cases, the $2^{1}/_{2}$- and 3-in. size, with the occasional use of 4-in. brick. The bituminous filler is more widely used than the sand or grout fillers due to its waterproofing qualities and its partial elimination of traction noises. M.C.S.

Brick-curb construction in Scioto County, Ohio. G. F. McKinney. *Proc. Nat. Paving Brick Assn.*, p. 20 (1935). Through the use of 4-in. wire-cut lug brick it has been possible to construct a more serviceable curb at lower costs for many of the Ohio highways. M.C.S.

Brick gutters and parking strips. Anon. *Dependable Highways*, No. 134, p. 4 (1932).—Vitrified brick are being widely used in the construction of gutters and parking strips. Brick gutters are smooth, clean, and sanitary and are not affected by water, acids, alkalis, oil, or grease. Brick parking strips provide a wear-resistant surface which is unsurpassed. M.C.S.

Brick from kiln to job. R. H. Berg. *Brick Clay Rec.*, **87** [3] 85–86 (1935).—Fired brick are piled onto wooden platforms 3 x 6 ft., 1000 brick or their equivalent of hollow tile to the load, at the kiln. By use of a special device on the truck, loads of units of 1000 brick are handled at one time and labor requirements are reduced to a minimum. Illustrated. E.J.V.

Brick paving for municipalities. R. L. Phillips. *Dependable Highways*, No. 133, p. 3 (1932).—Trends toward standardization of paving materials and practices have resulted in the favorable reception of vitrified paving-brick highways. More satisfactory foundations and cushions, improvements in the brick, and more stable fillers and improved methods of application have been instrumental in this adoption. M.C.S.

Ceramic products and their characteristics. J. A. Lavergne. *Rev. mat. constr. trav. pub.*, No. 309, pp. 81–84*B*; No. 310, pp. 97–100*B*; No. 311, pp. 120–23*B* (1935).—Tests were made on different types of ceramic products manufactured in the same way and to be sold under the same denomination and as the same quality. The testing conditions for all pieces being the same, the data obtained can be relied on, and comparisons which are of real value can be drawn. Variations in porosity values and absorption tests are discussed. The results of the tests are classified in the following order: (1) brick for construction, (2) face brick, and (3) paving brick and block. *Ibid.*, No. 312, pp. 136–42*B* (1935).—More tables showing the characteristics of products of different manufacturers are given and the data are compared and discussed. M.V.C.

Cracked sockets in sewer pipe. Maurice Barrett. *Brick Clay Rec.*, **87** [3] 98 (1935).—A simple and inexpensive method of overcoming the difficulty of cracked sockets in sewer pipe is described. Illustrated. E.J.V.

Design in reinforced brick masonry farm building. Judson Voodes. *Brick Clay Rec.*, **87** [3] 90–91 (1935).—A structure 30 ft. wide and 50 ft. long was built with semicircular beams or ribs which span the width with a radius of 15 ft. The ribs are spaced 7 ft. 2 in. apart and carry precast roof slabs consisting of brick laid flat, spanning between the ribs. The design is inexpensive in first cost and maintenance. Construction methods are described. Illustrated. E.J.V.

End lugs. Anon. *Dependable Highways*, No. 144, p. 7 (1934).—The adoption of methods for removing excess filler from the surface of brick roads has made it necessary to pay more attention to the thoroughness with which all of the joints in the pavement are filled and sealed. Some paving blocks are now being provided with end lugs which are nonmeshing and which provide a freer flow of the filler into the end joints as well as the side joints. M.C.S.

Foreign methods of brickmaking. A. B. Searle. *Claycraft*, **8** [10] 425 (1935).—A dissertation on the brick-making methods of Great Britain, Europe, and the U.S. is presented. European clayworkers usually employ a clay-cleaning machine before allowing the clay to proceed into the mixers. Pug mills with perforated barrels, perforated rolls, graters, and rolls with spiral grooves are used for this purpose. In most of Europe, clay slicers are used for breaking down the clay and preparing it preliminary to the mixing operation. These preliminary steps are usually necessary because of the inferior clays available and poor or nonselective mining. The methods of shaping the clay are dependent upon the nature of the clay under consideration. The stiff-plastic process is used very little in Europe, but soft mud, dry press, and semidry press are widely used throughout the major portion of the brick manufacturing industry. M.C.S.

Glazing textured brick with colors. H. L. Longenecker. *Brick Clay Rec.*, **87** [3] 89 (1935).—Textured brick, sprayed with glaze and fired under oxidizing conditions, are produced in a variety of colors. The texture of the brick breaks up the glaze so that all difficulties of glaze fit disappear. The glaze is a color medium instead of an impervious cover and a two-tone effect is produced. Formulas of typical glazes used are given. The use of slips and glazes is discussed, with the advantages and disadvantages of each. Methods of application to brick are described. E.J.V.

Plasticized sulfur as a jointing material for clay products. W. C. Ruekel and W. W. Duecker. *Bull. Amer. Ceram. Soc.*, **14** [10] 329–32 (1935).

Reinforced brick masonry opportunities in low-cost housing. Judson Voodes. *Brick Clay Rec.*, **87** [4] 119–21 (1935).—V. describes a wall of remarkable strength and unusual waterproofing properties that can be used in low-cost construction. Illustrated. E.J.V.

Report of the Research Bureau of the National Paving Brick Assn. W. C. Ruekel. *Proc. Nat. Paving Brick Assn.*, p. 22 (1935).—The work of this Bureau has covered four main problems: (1) elimination of exuding filler materials, (2) various methods of road construction leading to an increased utilization of clay prod-

ucts, (3) effect of separating agents on reducing the adhesion of the filler in joints, and (4) suitability of the present methods for testing paving brick in relation to their life in pavements. On an average, 25% of the road surface is covered by excess or exuded filler material one year after the road has been completed. To this fact is attributed the slipperiness of brick roads and their disintegration through the improper filling of the joints with its subsequent lack of waterproofing and protection of the foundation and cushion. Included in this report are tests of the exuding properties (due to heat) of various fillers, including plastic sulfur, a relatively new product which promises to be highly satisfactory for this purpose. The usefulness of the rattler test and the desirability of a standardization of the transverse strength test for paving brick are discussed. M.C.S.

Scumming of unusual type on buff brick. MAURICE BARRETT. *Brit. Clayworker*, **44** [521] 175 (1935).—The scum, which appeared on stiff-plastic buff building brick, developed during the drying process on surfaces exposed to the air and formed a hard, adherent skin of gray-white material on all exposed surfaces. After firing, the brick were badly disfigured by a semivitrified white scum. The analyses of this low-grade fire clay showed soluble sulfates as 1.76%. To overcome the scum, nine suggestions were made. The addition of ½% barium carbonate was a complete remedy. R.A.H.

Sewer-pipe costs. ANON. *Ceram. Age*, **23** [2] 52 (1934).—A method is described for determining production costs of sewer pipe of various sizes, based upon proportioning of costs in accordance with pipe weights. F.G.H.

Solving the problem of rough sewer pipe from standpoint of clays and firing. A. L. BOCK. *Brick Clay Rec.*, **87** [4] 124–26 (1935).—Practical methods used to test raw materials known to cause roughness and the firing procedure followed during the salt glazing period are described. E.J.V.

Specialized uses for paving brick. A. GOERTZ. *Dependable Highways*, No. 138, p. 3 (1933).—Careful tests have led to the adoption of paving brick for the wearing surfaces of the underground and subaqueous tunnels to be constructed by the City of New York. Paving brick were tested against and found more suitable than concrete, granite, steel, and asphalt. M.C.S.

Specifications for brick pavements. R. L. PHILLIPS. *Proc. Nat. Paving Brick Assn.*, p. 32 (1935).—Specifications for materials and methods of construction for brick roads are always changing and improving as a result of advances in research and the practical knowledge gained by contractors. A general outline of the various specifications is included, covering paving brick, bed materials, and filler, and the construction methods for laying the bed course and the brick, rolling, and expansion joints. M.C.S.

Surface removal of filler application in brick-pavement construction. O. W. MERRELL. *Dependable Highways*, No. 139, p. 3 (1933).—The removal of the surplus filler on brick pavements is accomplished by coating the brick just prior to the application of filler with whitewash, calcium chloride in solution, or a patented mixture bearing the trade name, "B and B." Through the proper application of one of these mixtures it has been possible to remove 80% of the surplus filler which ordinarily remains on the surface of the road. M.C.S.

Typical designs for brick resurfacing over worn concrete as constructed in 1932. ANON. *Dependable Highways*, No. 135, p. 4 (1932).—Methods of resurfacing concrete with brick as practiced in Ohio, Ill., and Ind. are discussed. The width of the original concrete road largely determines the method of resurfacing, but invariably the resurfacing is accompanied by a further widening of the road. As a rule the old concrete roads serve admirably as a foundation for the new brick road. M.C.S.

Vitrified brick curb. ANON. *Dependable Highways*, No. 144, p. 6 (1934).—Vitrified brick are finding increased adoption in the construction of curbs. High durability and resistance to weather are the chief factors contributing to the success of these constructions. M.C.S.

Vitrified brick pavement in Philadelphia. W. C. PERKINS. *Proc. Nat. Paving Brick Assn.*, p. 17 (1935).—De-aired paving brick were chosen as the paving material for much-traveled Chestnut Street in Philadelphia. Particular care was taken to obtain a smooth surface by proper preparation of the base and bedding course before the brick were placed and by removal of the excess filler after laying the brick. M.C.S.

BOOKS

Brickwork in Winter. V. V. SIZOV. Chief Editorial Office of Bldg. Ind., Moscow, 1935. 72 pp. Price 75k. This useful brochure contains 203 practical questions and answers devoted to all phases of brickwork in winter. S. I. PERKAL

Use of Brick in French Architecture: Part I, The Midi. WILLIAM EMERSON AND GEORGES GROMORT. 94 pp. Architectural Book Pub. Co., Inc., New York, 1935. One can not do justice to this book, illustrated as it is by 15 pencil drawings, 20 measured drawings and maps, 86 photographs, with text, and a bibliography. In a day when prefabricated construction is being promoted and statements are current, such as that of Ely Jacques Kahn, that the day of wet construction, *i.e.*, cement- and mortar-laid units, is past, it is indeed refreshing to peruse a book that beautifully sets forth the architectural availability of brick and terra cotta. We quote the foreword by Ernest John Russell, President of the American Institute of Architects, 1932–1935:

Brick is essentially a local product, each district utilizing the material at hand in its manufacture and its own labor for building operations. As these districts are distributed throughout the world and as each one worked out its own problem independently, there is an infinite variety in size, color, form, and texture of the material itself and in the methods of laying. The bonds and patterns are oftentimes ingenious and are usually in accord with the simplicity or the importance of the structure.

To the thoughtful designer it has an individual charm and interest that justify its use in structures that please as well as endure.

Because it has been used so long and so freely, there is a general impression that it is only one of many building materials, but its history demonstrates that it is a perennial favorite capable of outliving the fads and fancies that rise and fall for other materials in almost regular cycles.

France has much to contribute to the story of Brick, and has demonstrated its appreciation by its appropriate use in structures on the farm, in villages, and the cities of importance.

The chapters written as a labor of love by Professors Emerson and Gromort, and so splendidly illustrated by Samuel Chamberlain, accent anew the position this material holds in the opinion of the architectural profession and of the discriminating public. As brick will be used as much in the future as it has been in the past, this story which is so sympathetically told will be a storehouse of knowledge, particularly to the present and future practitioners.

ROSS C. PURDY

PATENTS

Brick. C. P. AUSTIN. U. S. 2,018,541, Oct. 22, 1935 (July 30, 1932). A corner facing brick comprises a substantially rectangular block having a cut through its body for a portion of its length and a second cut at an angle to and intersecting the first cut, the portions of the block divided by the cuts adhering together and being separable by tapping, one of the portions extending from a point spaced from one end of the block and from substantially half the width thereof, for the rest of the length of the block and leaving a substantially L-shaped corner facing brick.

Building block. C. R. BUYER. U. S. 2,019,653, Nov. 5, 1935 (June 14, 1932).

Building and refractory brick or blocks. L. E. HAMSON AND BRIXWORTH BRICK & TILE CO., LTD. Brit. 434,127, Sept. 11, 1935 (Feb. 23, 1934).

Fireclay sewer-pipe body. W. K. CARTER AND G. H. DUNCOMBE, JR. (National Aluminate Corp.). U. S. 2,019,619, Nov. 5, 1935 (July 13, 1934). The process of making weathering-resistant ceramic pipe intended for underground use comprises tempering fire clay with water containing an amount of sodium aluminate not substantially exceeding 1% of the weight of the clay, forming the resulting plastic mass into shape, drying the shape, and firing it at a temperature equivalent to about cone 8.

Loading of sewer pipe, building tile, etc., for railway shipment. I. H. SPOOR (Gerrard Co., Inc.). U. S. 2,016,461, Oct. 8, 1935 (June 25, 1931).

Masonry structure with joints. E. B. GATES (Atlas Mineral Products Co.). U. S. 2,015,470, Sept. 24, 1935 (June 9, 1933).

Method of making molded products. A. S. BROCK AND C. F. MEINZER (Wallace L. Caldwell). U. S. 2,016,796, Oct. 8, 1935 (July 25, 1934). A process of making molded products comprises mixing pulverized slag and alkali silicate and steam-curing the mixture under superatmospheric pressure.

Process of producing lightweight aggregate and the product thereof. C. K. HARDING. U. S. 2,015,381, Sept. 24, 1935 (Sept. 28, 1934). A process of producing lightweight aggregate comprises dividing a batch of expansible, fusible, raw ceramic material into relatively small pieces, coating the exterior sufaces of the pieces with a refractory material, and subjecting the coated pieces in bulk condition while in contact with other pieces to the action of hot gases until the temperature of the fusible and expansible bodies of individual pieces is raised to effect the fusing and expanding of the pieces, while clinkering of the bulk is avoided by the refractory coatings.

Reinforced brick building construction. H. J. HINCKE. U. S. 2,019,133, Oct. 29, 1935 (May 27, 1933).

Tile for joist and tile construction for floors. H. F. FREASE. U. S. 2,017,241, Oct. 15, 1935 (May 23, 1931; Dec. 12, 1932).

Refractories

Brickmason and the open-hearth furnace: V. HENRY D. TYSON. *Blast Fur. Steel Plant*, **23** [10] 698–700 (1935).—The construction of the furnace proper is discussed in detail. The bottom construction should be such as to outlast the rest of the furnace. The tapping-hole construction, roof construction, and repair work are taken up at length. For Part IV see *Ceram. Abs.*, **14** [11] 278 (1935). E.J.V.

Caustic magnesia lining for arc furnaces. V. BOGOLUBOV. *Novosti Tekhniki*, No. 37, pp. 1–2 (1934); abstracted in *Referat. Silikatliteratur*, No. 606 (1934).—In contrast with sintered magnesite (firing temperature 1615 to 1750°), caustic magnesite (fired at 800 to 1000°) shows hydraulic properties. Chemically and physically both kinds of magnesite are similar except that caustic magnesia has a finer crystal lattice. Its advantage lies in the fact that it crystallizes more easily than sintered magnesite. The rammed linings used in electrometallurgy, containing tar, molasses, or water-glass, are unsatisfactory. The Moscow Steel Institute developed a rammed mix for arc furnaces, consisting of 80% sintered and 20% caustic magnesite, which recrystallizes with every melting and changes finally into a monolithic structure resisting highly oxidizing melts. Such linings were used successfully in Heroult arcs for melting steel and ferrochrome. M.V.C.

Chemical changes in the semi-acid masonry of coke ovens. R. N. GOLOVATNUĬ. *Ogneuporui*, **3** [4] 277–80 (1935).—A description and chemical analyses of different zones of brick after 18 months' work are given. The changes of the chemical composition take place chiefly through the absorption of iron oxides by the surface layer and the formation of low-melting silicates. The slag layer protects the brick from corrosion. The deposition of carbon in the mass of the brick contributes to the adherence of the slag layer with the brick by loosening its structure but lowers its mechanical strength. The oxides of alkali metals did not lead to any disturbances, the coke ash being acid. P.B. & E.S.

Classification of insulating refractories. E. J. BOGNAR. Presented before the Electrochemical Society; abstracted in *Brit. Clayworker*, **44** [522] 213 (1935).—B. describes and gives the properties of insulating refractories which are classed into (1) super-refractory insulators, (2) refractory insulators, and (3) semi-refractory insulators. R.A.H.

Destruction of grog brick by carbon monoxide. P. P. BUDNIKOFF. *Novosti Tekhniki*, No. 26, p. 11 (1934); abstracted in *Referat. Silikatliteratur*, No. 612 (1934).—It was found that (1) FeS_2 present in the clay changes into oxide when fired. (2) Iron oxide acts as a catalyzer during the reaction $2CO \rightleftharpoons CO_2 + C$ and promotes the course of reaction to the right side; Fe_2O_3 is reduced to FeO. The precipitated carbon deposits in the pores of the brick and destroys them. The iron spots show the beginning of the destruction. (3) The oxidation of CO to CO_2 with the

precipitation of C lies at 450 to 500°C. At higher temperatures the equilibrium moves to the left side of the equation and C does not precipitate. (4) With a definite iron content and degree of mullitization, the volume porosity of the brick becomes an important factor in the stability of the products. (5) An addition of small amounts of copper sulfate to the mix increases the resistance of grog brick to the effect of carbon monoxide. It is therefore recommended that (*a*) the iron content of the brick be reduced to 1 or 1.3%; (*b*) the remaining iron be uniformly distributed in the brick; (*c*) the porosity be not over 18% in the brick; and (*d*) the brick be fired between 1300 and 1350° in a reducing atmosphere. The ferrous oxide formed in this case makes the body dense and promotes the formation of mullite. A "protective layer" is formed under these conditions which increases the chemical resistance of the brick. M.V.C.

Detection by X-ray examination of tridymite in coke-oven silica brick and its technological importance. K. Endell, U. Hofmann, and E. Maegdefrau. *Glückauf*, **71** [36] 862–63 (1935).—Tridymite brick are considered the best material for the chambers of a coke oven, *i.e.*, a silica brick which consists exclusively of tridymite crystals. Methods of producing such brick, *e.g.*, from sodium oxide and iron oxide-containing fluxes, are discussed. The only sure way of detecting tridymite is by X-ray analysis as the crystals can not always be recognized in a thin section. The investigations showed that it is possible to develop more than 80% tridymite crystals in comparatively pure quartzites with about 2% CaO addition and good firing, as the small amount of natural fluxes contained in quartzite is sufficient for the transformation. Satisfactory tridymite brick for coke-oven chambers can be produced in this manner. M.H.

Developments and trends in refractories: I–II. Louis J. Trostel. *Blast Fur. Steel Plant*, **23** [10] 703–705 (1935); *Brick Clay Rec.*, **87** [3] 92–94; [4] 127–30 (1935).—Cyanite and olivine refractories have been tested. Among the electro-cast refractories are Corhart's cast mullite and a European electro-cast chrome spinel made from chromite, magnesite, and bauxite, called Siemensit. The General Refractories Co. has developed a Ritex process of producing unfired refractories, making magnesite and chrome brick by this process. The Ritex brick have a better resistance to spalling than fired brick. Insulating fire brick for high temperatures have been developed by inducing high cellularity and proper strength in refractory clays and other materials. Vermiculite, as well as diatomaceous earth, has been incorporated in insulating brick for use in furnace exteriors. Applications and uses of newer refractories are discussed. E.J.V.

Effect of carbon monoxide on refractory products. A. I. Kramarenko. *Novosti Tekhniki*, No. 59, p. 15 (1934); abstracted in *Referat. Silikatliteratur*, No. 669 (1934).—Grog brick containing from 3 to 6% hematite, pyrite, magnetite, and metallic iron were tested for their resistance to carbon monoxide. It was found that (1) the destruction of grog brick increases with increased iron content, (2) the coarser the addition, the more rapidly the brick are destroyed, and (3) a more severe firing of the brick increases their resistance, although much better results were obtained when 5 to 10% powdered amorphous quartzite was added. M.V.C.

Effect of heat treatment on spalling of clay refractories. S. M. Phelps. *Penn. State Coll. Mineral Ind. Expt. Sta. Bull.*, No. 14, pp. 57–66 (1934).—The fact that spalling of refractories in service is a major cause of failure has promoted much study of the subject. The factors involved in spalling are discussed from the following viewpoints: (1) set-up of stresses within the brick as a result of vitrifying one face of the refractory previous to spalling, (2) change in reversible thermal expansion caused by heat treatment of the face, (3) effect of heat treatment or vitrification on the rhelasticity within the brick structure, and (4) cracking of the face of the brick so as to form an interlocking of the structure of adhering particles. H.E.S.

Effect of insulation on silica refractories of an open-hearth steel furnace roof. Lewis B. Miller. *Bull. Amer. Ceram. Soc.*, **14** [11] 359–64 (1935).

Effect of viscosity of the slip on porosity of glasspots produced by casting. R. Moretti. *Ind. Vetro Ceram.*, **7** [8] 321–25 (1934); abstracted in *Referat. Silikatliteratur*, No. 866 (1934).—It was found that lowering the viscosity effects a decrease in porosity; it is unimportant whether viscosity is obtained by surplus of liquefacients or water. M.V.C.

Electrical conductivity of refractory brick in relation to the iron oxide content. J. Kratzert and F. Kaempfe. *Ber. deut. keram. Ges.*, **16** [6] 296–306 (1935).—Using Zettlitz kaolin and a clay containing 8.64% Fe_2O_3, a series of mixtures having Fe_2O_3 contents of 4, 2.5, 1.5, and 0.86% was prepared, and the electrical conductivity was determined on specimens fired oxidizing at 1250° and 1500° and reducing at 1250°. The material fired oxidizing at 1250° showed a direct inverse relationship between specific resistance and iron oxide content. The material fired oxidizing at 1500° and reducing at 1250° did not show this linear relationship due to the effect of the FeO content. The material fired oxidizing at 1500° showed the best insulating properties, while that fired reducing at 1250° showed the poorest, especially at the higher iron content. For practical purposes the results indicate that the best insulating material is one fired oxidizing to a high temperature and having a low Fe_2O_3 content (below 1%). E.J.V.

Flin Flon copper smelter of the Hudson Bay Mining and Smelting Co., Ltd. J. H. Ambrose. *Can. Mining Met. Bull.*, No. 281, pp. 402–20 (1935).—There is probably a larger proportion of magnesite brick in the furnace than in any other reverberatory furnace. Under smelting conditions at Flin Flon, magnesite brick in certain sections has been found to decrease brickwork costs and to prolong furnace life. The geographical location of Flin Flon makes the percentage of price differential between magnesite and silica brick lower than in most smelters. G.M.H.

Influence of additions of iron chromite and bauxite on the fundamental properties of magnesite refractories. S. N. Myshkin. *Ogneuporui*, **3** [4] 243–48 (1935). P.B. & E.S.

Insulating brick. Illinois Clay Products Co. *Blast Fur. Steel Plant*, **23** [10] 728 (1935).—A new type of insulating brick, obtained from a mixture of Therm-O-

Flake granules (made from exfoliated vermiculite) with a special ceramic bond, has the following characteristics: (1) extreme light weight, about 18 oz. each, (2) a strong tough structure, (3) excellent insulation value with low thermal conductivity, (4) unusual stability of insulation, (5) load-bearing property varying from 47 lb./in.^{2} cold crushing strength to 32 lb./in.^{2} at 1800°F, and (6) density of 21 lb./cu. ft. It is recommended for temperatures behind refractories up to 2000°F when not loaded over 30 lb./in.^{2} E.J.V.

Investigation of the use of magnesium aluminate (spinel) as a material for glassmelting containers. C. W. Parmelee and K. C. Lyon. *Jour. Amer. Ceram. Soc.*, **18** [11] 338–40 (1935).

Kinetics of solid-phase reactions of certain carbonates with mullite, silica, and alumina. Gordon R. Pole and Nelson W. Taylor. *Jour. Amer. Ceram. Soc.*, **18** [11] 325–37 (1935).

Kyanite in crucibles for glassmelting. S. R. Scholes. *Bull. Amer. Ceram. Soc.*, **14** [10] 335–37 (1935).

Manufacture of grog brick by means of dry pressing. A. K. Freberg. *Zbornik Statei Ogneuporui Prom.*, pp. 169–238 (1934); abstracted in *Referat. Silikatliteratur*, No. 1379 (1935).—Consecutive stages of the manufacture of grog brick, according to the dry pressing method, are discussed in detail. M.V.C.

Materials used for the production of porous ware. Anon. *Ziegelwelt*, **65** [23] 241–42 (1934); abstracted in *Referat. Silikatliteratur*, No. 1329 (1935).—The use of coke, coal, lignite, pit, and sawdust to produce porous brick is discussed. M.V.C.

Method of testing aluminous refractory materials at high temperature. B. Long. *Rev. mat. constr. trav. pub.*, No. 310, pp. 110–11*B* (1935).—L. recommends the recording of the softening under load at constant temperature of a cylinder 5 cm. in diameter and 5 cm. high. The equipment, furnace, pyrometer, and Wilson-Maeulen temperature regulator are described. After application, the softening curve is registered during at least 12 hr. The different results obtained are compared with those of former tests at variable temperature. With the new method the influence of the total porosity can be detected. After contraction of the pores, the apparent viscosity intervenes; it characterizes the industrial value of a silico-aluminous refractory. M.V.C.

Petrography and heat treatment of chromite refractories. G. E. Seil. *Penn. State Coll. Mineral Ind. Expt. Sta. Bull.*, No. 14, pp. 40–56 (1934).—The application of the petrographic microscope has revealed that chrome ores consist of a primary component (comprising about 75 to 90% of the ore) having a definite crystalline form in which the molecular percentage of MgO and FeO equals the molecular percentage of Cr_2O_3 and Al_2O_3. The secondary components (comprising about 25 to 10% of the ore) are usually magnesium silicates varying in composition from $3MgO{\cdot}2SiO_2$ to $2MgO{\cdot}3SiO_2$. The state and relative position of the secondary component of the ores is believed to cause many of the difficulties, failures, and undesirable properties of chromite refractories. Superior chromite refractories were developed by physically and chemically correcting chrome ores to produce a crystalline (bolstered forsterite) bond instead of the usual glassy bond. A combination twin-microscope instrument is described in which physical and chemical changes during heating of the refractory may be recorded and accurate expansion curves determined. This instrument is also of value in determining the proper time and temperature relationships to be used in plants firing such refractories. H.E.S.

Refractories with a high resistance to spalling. A. I. Kramarenko. *Ogneuporui*, **3** [5] 358–60 (1935).—Brick for suspended arches of boiler furnaces were made of a clay with a high alumina content of the following composition: SiO_2 54.48, Al_2O_3 43.18, Fe_2O_3 1.10, CaO 0.86, MgO 0.18, and ignition loss, 0.32%. No plastic clay was added. The brick possessed a high resistance to spalling; cracks appeared after 13 coolings; pieces fell off after 54 coolings. P.B. & E.S.

Results of operating the Terni open-hearth furnace. O. Göbel. *Stahl & Eisen*, **55** [33] 882–90 (1935).—This new type of open-hearth furnace was tested over a considerable length of time. Detailed information is given regarding the construction, output, heat economy, and life of the Terni furnace. Cooling of parts of the furnace by waste gas will improve its stability. W.M.C.

Sagger clays and sagger bodies. Raymond A. Heindl. *Jour. Research Nat. Bur. Stand.*, **15** [3] 255–70 (1935); R.P. 827. Price 5¢.—Fifty-one clays used for sagger making and representing mining districts in N. J., Ky., Ohio, Tenn., Calif., Ga., Ill., Pa., and S. C. were used in this investigation; 85 bodies were prepared and tested in the laboratory. In these bodies, 2 series of grog sizes were used, *i.e.*, one series of comparatively coarse and the other of comparatively fine sizes of grog, and 6 heating temperatures. In addition, 17 sagger bodies used in commercial practice were tested. Two of these bodies contained talc, 2 contained magnesite, and another of the same clay and grog composition as the preceding 4 was free from either talc or magnesite. The chemical compositions and P.C.E. of the clays and the results of such tests of the physical properties of both clays and bodies as shrinkage, porosity, modulus of rupture, Young's modulus of elasticity, linear thermal expansion, plastic deformation, and resistance to thermal shock were reported in detail in preceding reports. In this report reference is made only to extreme values. From data obtained in the entire investigation a chart was prepared which, it is believed, will permit the manufacturer of saggers to predict with a reasonable degree of accuracy the relative length of service which may be expected from saggers made from combinations of clays of which some of the properties have been determined. The following conclusions are thought to be most significant: (1) Any sagger body having a total linear expansion from room temperature to 250°C of approximately 0.18% or greater can not be expected to have a high resistance to thermal shock. (2) The life of the sagger is more sensitive to changes in thermal expansion than to changes in extensibility or "stretch" of the sagger body. (3) There is no relation between changes in modulus of elasticity and porosity. Great increases in this modulus may accompany changes in grog sizes from coarse to fine or higher temperatures of heating with very little change in porosity. (4) Bodies containing porous grog are more resistant to thermal shock than bodies containing dense or vitreous grog. (5) Angular and loosely bonded

grog particles in a body result in a high extensibility or stretch, which in turn gives the body increased resistance to heat shock. (6) The plastic deformation at 1000°C is less in fine-grogged bodies than in coarse-grogged bodies and decreases with increase of heating temperature. The flux content is an important factor in causing plastic deformation and is more serious if the silica content is high. (7) The addition to a sagger body of magnesia, either as talc or magnesite, will lead to increased sagger life, but care must be taken to control the quantity present, since both the refractoriness and plastic deformation may be affected detrimentally if too much magnesia is present. (8) It is very desirable, and should prove profitable for the manufacturer, to analyze the conditions of service under which his saggers are to be used. In most cases it is impossible to prepare, from the ordinary sagger clays, bodies which have properties ideally suited for long life in all types of service. Therefore, by knowing certain properties of the clays and grogs available, only those suitable for his service would be used for making sagger bodies. R.A.H.

Silica framework crystals and their stability fields. M. J. Buerger. *Z. Krist.*, **90**, 186–92 (1935).—The open structures of the stable high-temperature forms of silica, tridymite, and cristobalite are dynamically maintained by thermal agitations but may be statically maintained at low temperatures by inclusions of foreign ions, preventing the inversion to the closer-packed quartz structure. The natural tridymite and cristobalite minerals are not necessarily unstable phases formed under permission of Ostwald's rule but may be stable, impure silica. H.I.

Simplified method of testing the compressive strength of siliceous brick. Tchernuishev and Kashirov. *Stroitel. Material*, No. 4, pp. 12–14 (1935).—The samples were placed in the press edgewise. This permitted undertaking the testing earlier than usual and eliminated the making of standard samples. P.B. & E.S.

Suitability of silicon carbide brick. R. Klesper. *Sprechsaal*, **68** [25] 385–88 (1935).—After a review of the production and properties of silicon carbide brick, laboratory tests with such brick are described. It was found that (1) the brick are destroyed by comparatively low temperature when subjected to it for a long time, (2) an outside protective layer delays the oxidation of the interior of the brick, and (3) at higher temperature even the protecting surface does not prevent the destruction of the brick. The results of the use of silicon carbide in muffles for the enamel industry, in muffles for calcining steel pipes, etc., are discussed in detail. M.V.C.

Tarasovka (Ukraine) quartzite for the production of silica brick. E. I. Kheifetz. *Ogneuporui*, **3** [4] 269 (1935). P.B. & E.S.

Thermal conductivity of refractories at high temperatures. *Rept. Nat. Phys. Lab.* [London], pp. 26–27 (1933).—An apparatus for the measurement of thermal conductivities at high temperatures is described. It permits routine tests on slabs of brick 18 in. square, $1^1/_2$ to 3 in. in thickness, and up to a hot-face temperature of 1100°C. In tests carried out, the slab of material was mounted horizontally and constituted the top of an air enclosure heated by a number of Silit rods. The temperature of the lower face of the slab was measured by an optical pyrometer sighted through small windows built into the bottom of the enclosure. The heat transmitted was measured by means of a continuous-flow water calorimeter and guard ring laid on the upper surface. The apparatus is also adaptable for the measurement of thermal conductivities over restricted ranges of temperature. G.H.A.

MAP

Map of Refractories Plants. Published by J. H. H. Muirhead, New York. Price $1.00. *Ceram. Age*, **25** [1] 27 (1935).—A directory of refractory plants in different parts of the U.S. is given in map form, compiled from lists of the American Refractories Institute. The size of the map is 17 x 22 in. F.G.H.

BOOKS AND BULLETINS

Hi-cast refractory concrete. Anon. *Denver Fire Clay Co. Bull.*, No. 147; Reviewed in *Power*, **78** [9] 536 (1934).—A method of applying refractories which permits the refractory to be actually cast on the job just as concrete is cast is described. F.G.H.

General Course in Refractories Technology. A. I. Avgustinnik. Onti, Leningrad, 1935. This student's course is based on the latest developments in the industry. The book is divided into two parts, the first devoted to grog refractories, the second to silica. Technical requirements, raw materials and their preparation, and molding, drying, and firing processes are discussed.

P. P. Budnikoff and E. E. Stefanowsky

Refractory Blocks for Glass Tank Furnaces. J. H. Partridge. Society of Glass Technology, Sheffield, 1935. x + 128 pp. Price 6s 6d to members of the Society and 8s 6d to nonmembers. This monograph with a foreword by W. E. S. Turner is a valuable contribution to ceramic technological literature. Apart from its special appeal to the glass manufacturers who use tank blocks and the refractories manufacturers who make them, the book is of no less interest to the technologists and to the manufacturers of glassmelting pots and other refractory articles which are exposed to the action of glasses and slags. Chapter I deals with the definition, general considerations, and conditions of service of tank blocks. Chapters II and III are devoted to the raw materials. Composition, physical properties, impurities, treatment, weathering, removal of iron-bearing minerals, washing, and grinding are considered in connection with the plastic materials. Definition, purpose, sources, physical properties, structure, packing arrangements of different sizes of particles, and porosity of grog particles are discussed in connection with nonplastic materials. The next chapter describes the preparation of the clay mixture, dry and wet mixing, blunging, effect of entrapped air, and de-airing. In Chapter V methods of shaping blocks are taken up, which include hand molding, hand and mechanical ramming, machine pressing (semidry process), extrusion, casting from slip, and "electro-casting" from electrically fused materials. Chapter VI discusses drying, firing, and dressing of the finished blocks. In Chapter VII common defects occurring in tank blocks are enumerated and their causes are traced. Chapter VIII treats of the behavior of the tank blocks in the furnace by giving a general description of the tank furnace and its mode of operation. In the next two chapters physical, chemical, and corrosion-resisting tests are outlined.

Among the physical tests discussed are after-contraction, crushing strength, density and porosity, spalling, and compressive and tensile strength at elevated temperatures. Among the tests on the evaluation of corrosion resistance, which are briefly reviewed, are penetration of the corrosive agent, determination of the amount of refractory dissolved, tests of refractory in the form of container or crucible, change in composition of the corroding agent, attack of hydrofluoric acid, corrosion of small-scale tank furnaces, and indirect methods of tests such as Seger cone test, determination of the mullite content, etc. These are followed by the suggestions which are offered as a basis on which tests for resistance to corrosion might be formulated. In Chapter XI experience gained from commercial furnaces is set forth; in connection with this, items such as examination of a large tank furnace, effect of batch composition, improvements in furnace design, insulation, cooling, effect of joints, and use of better blocks are discussed. In the last chapter a technique for testing tank blocks is suggested and a tentative specification for tank blocks is proposed. At the end of the book there is a useful list of 210 references bearing on the subject. See also "Review—" *Ceram. Abs.*, **13** [2] 36 (1934).

ABDE ALLY

Specifications for Material Testing. Report No. 9. Second Report of the Commission for the Investigation of Refractory Materials. The Hague, July, 1935. 200 pp. Price 2.00 guilders. The commission considers its work finished with the present report, which includes discussions and definitions, comparisons with methods and regulations of other countries, characteristics and properties of refractory materials, Seger cones, deformations under pressure and under heat, chemical composition, thermal behavior, measuring methods, and practical data. Each chapter is complete in itself and contains theoretical principles, measurements, practical results, concrete suggestions for the standards to be adopted, and a list of bibliographical references. Of particular interest and great practical value is Chapter 8, which deals with the attack by slags of refractories of widely differing chemical compositions; this chapter alone cites 111 bibliographical references. Chapter 13 discusses refractory mortars of which are distinguised three groups: (1) silica mortars, having a content of more than 88% Si; (2) fireclay (chamotte) mortars with an Al_2O_3 content of 20 to 40% and which are again subdivided into "acid" chamottes with 20 to 30% Al_2O_3, "neutral" chamottes with 30 to 35% Al_2O_3, and "basic" chamottes with 35 to 40% Al_2O_3; and (3) special mortars, comprising highly basic chamottes with more than 40% Al_2O_3, silicon carbide mortars, zirconium-containing mortars, and others. The influence of grain size is of even greater importance in mortars than in brick; silica mortar, especially, should have a fine grain to possess good binding properties. The volume is well printed and so concisely written that it makes good reading.

M. HARTENHEIM

PATENTS

Ceramic mixes, siliceous refractory articles or ware, and processes of producing. NATIONAL ALUMINATE CORP. Brit. 435,348, Oct. 2, 1935 (Sept. 25, 1933).

Checkerwork construction. S. L. MAMULA AND JOSEPH MUHVICH. U. S. 2,017,763, Oct. 15, 1935 (Jan. 18, 1935).

Firebridges applicable to boiler furnaces, etc., for effecting smoke consumption. G. W. RIDGWAY. Brit. 434,492, Sept. 18, 1935 (Feb. 27, 1934).

Fired siliceous tribarium aluminate refractory. J. M. MCKINLEY AND W. K. CARTER (National Aluminate Corp.). U. S. 2,017,723, Oct. 15, 1935 (Sept. 25, 1933). The process of bonding highly siliceous particles to produce refractory articles comprises the steps of mixing the particles with an aqueous dispersion of barium aluminate and drying and firing the resultant mixture.

Furnace refractory. G. J. EASTER (Carborundum Co.). U. S. 2,017,056, Oct. 15, 1935 (April 17, 1934). The method of producing cast refractory blocks with a large proportion of corundum crystals from raw materials containing alumina and silica comprises melting raw materials consisting essentially of alumina and silica, casting the molten mixture, and cooling the casting rapidly through the stage at which the crystallization of mullite would result by allowing the mass to come to equilibrium.

Manufacture of compressed refractory materials. SOC. ANON. DES PRODUITS RÉFRACTAIRES ET CÉRAMIQUES DU NORD. Brit. 435,076, Sept. 25, 1935 (Nov. 9, 1933).

Manufacture of fireproof nozzles for ladles. ALLMÄNNA SVENSKA ELEKTRISKA AKTIEBOLAGET. Brit. 434,520, Sept. 18, 1935 (March 23, 1934).

Production of alumina. R. B. DERR (Aluminum Co. of America). U. S. 2,019,554, Nov. 5, 1935 (July 19, 1932). In a process of extracting alumina from aluminous material by digesting the material with a solution containing nitric acid to form aluminum nitrate liquor which is concentrated and increased in basicity and cooled to crystallize aluminum nitrate, a step comprises adding mother liquor from the aluminum nitrate crystallization to aluminum nitrate liquor from the digesting stage.

Production of alumina. C. B. WILLMORE AND C. C. CALLIS (Aluminum Co. of America). U. S. 2,019,553, Nov. 5, 1935 (July 19, 1932). A process of producing alumina comprises treating aluminous material with nitric acid in the presence of a fluorine compound to form aluminum nitrate and decomposing the aluminum nitrate by heat.

Production of nonspalling highly refractory chromite brick. OESTERREICHISCH AMERIKANISCHE MAGNESIT A.-G. Brit. 435,448, Oct. 2, 1935 (April 5, 1933).

Refractory brick. CARL OTTO. U. S. 2,018,223, Oct. 22, 1935 (July 1, 1931).

Refractory ceramic. J. M. MCKINLEY AND W. K. CARTER (National Aluminate Corp.). U. S. 2,019,618, Nov. 5, 1935 (Sept. 25, 1933). A process of producing highly heat-resistant strong fire brick exhibiting marked decrease in porosity, great crushing strength, resistance to spalling, and diminished firing shrinkage comprises mixing fire clay with aggregates and an amount of sodium aluminate substantially equal to about 1 to 5% of the weight of the clay and water to form a plastic mass, forming the mass into shapes, and drying and firing it.

Refractory for glass tanks. R. C. BENNER AND H. N. BAUMANN, JR. (Carborundum Co.). U. S. 2,019,209, Oct. 29, 1935 (April 17, 1934). A cast refractory article consists of 85 to 97% alumina, 1 to 10% of an alkaline oxide, and 2 to 14% silica.

Refractory product. H. N. BAUMANN, JR., AND

CHARLES MCMULLEN (Carborundum Co.). U. S. 2,019,208, Oct. 29, 1935 (Dec. 16, 1933). A fused cast refractory article is produced from the fusion of about 2 to 10% magnesia and the remainder substantially alumina, the microstructure of the casting consisting principally of interlocking crystals of magnesia spinel and crystals of alumina.

Siliceous refractory. J. M. MCKINLEY (North American Refractories Co.) AND W. K. CARTER (National Aluminate Corp.). U. S. 2,019,542, Nov. 5, 1935 (June 7, 1934). A process of making refractories comprises mixing ganister particles with an aqueous dispersion of a barium compound from the group consisting of acetate, hydroxide, nitrate, peroxide, and carbonate, molding the mixture into shape, drying the shapes, and firing them.

Silicon carbide refractory and process of manufacture thereof. R. C. BENNER, G. J. EASTER, AND J. A. BOYER (Carborundum Co.). U. S. 2,015,778, Oct. 1, 1935 (Oct. 12, 1934). A recrystallized silicon carbide refractory is composed of self-bonded silicon carbide grains and has a permeability of less than 75.

Stable dicalcium silicate refractory composition. A. T. CAPE AND K. B. BOWMAN (Republic Steel Corp.). U. S. 2,015,446, Sept. 24, 1935 (March 9, 1931). A stabilized silicate refractory substance contains between about 65 and 95% of lime, silica combined with a portion of the lime in the form of dicalcium silicate, and between about $^1/_2$ and 10% of a phosphate capable of stabilizing the dicalcium silicate.

Wall plate for furnaces. E. B. TOLMAN, JR. U. S. 2,017,675, Oct. 15, 1935 (June 21, 1934).

Terra Cotta

Disintegration of roof tile. ANON. *Clay Prod. Jour. Australia*, **2** [10] 27 (1935).—An English college, erected ten years ago, is having to replace 20,000 tile because of slipping. The nuts have disintegrated to the extent of rendering the nail-holes ineffective. Failure of the tile is attributed to efflorescence of soluble salts, principally $MgSO_4$, assisted by the presence of heating pipes in the roof space. Recommendation is made to the British Standard Specification No. 402–1930 for clay plain roofing tile. H.H.S.

"Dunting" of blue goods and its remedy. MAURICE BARRETT. *Brit. Clayworker*, **44** [522] 203–204 (1935).—There are two main causes for the occurrence of dunts: (1) too high a percentage of silica in the clays, and (2) the use of tight firing clays of low tensile strength. Dunting is also frequently due to too high a percentage of nonplastics, and laminations are undoubtedly playing an important rôle in producing this defect. R.A.H.

Firing ceramic stoneware tile. F. CHALAMEL. *Rev. mat. constr. trav. pub.*, No. 310, p. 110*B* (1935).—The practical and simple instructions given are the result of 30 years of studies at the plant and in the laboratory. Products which go to the furnace without preliminary drying must be heated to expel moisture; it requires at least 48 hr. to reach 100°. In the absence of thinning agent or if the pieces are more than 18 mm. thick, this low fire must last 75 hr. It is difficult to fire thin and thick tile or clay and clay-feldspar pieces at the same time. All-clay products must be dried beforehand. Thick tile can be pressed to advantage. In an intermittent kiln with inverted, flame clay-feldspar tile 140 x 140 x 15 mm. must be fired in an oxidizing atmosphere to 1300° for 150 hr. of rising temperature. In a continuous tunnel kiln, C. was able to reduce the time to 96 hr. After the normal temperature is reached and if it is uniform in all parts of the furnace, it is not necessary to maintain it since it would result in the excessive formation of sillimanite with the tendency toward irregular lengthening. Normal cooling lasts 48 hr. in an intermittent furnace and 24 hr. in a continuous. More rapid cooling causes cracks. In a continuous kiln very vitrifiable mixtures cause bubbles. A smoking flame at vitrification temperature causes blisters. M.V.C.

Firing large terra cotta panels in small special kiln. ANON. *Ceram. Ind.*, **25** [3] 148–50 (1935); *Brick Clay Rec.*, **87** [3] 87–88 (1935).—Using a downdraft car-type periodic kiln with a firing chamber only large enough to hold five pieces 30 x 24 x 7 in. in size, seven large panels of unglazed ornamental terra cotta figures, weighing 15 tons, were fired by the Ceramic Engineering Department of Iowa State College. The kiln was built around an old drier car. The molding and firing of the pieces was done by students under the direction of Paul E. Cox. Illustrated. E.J.V.

Lubricated valve in earthenware (Semper-Densum valve). L. MELZER. *Werkstoffe & Korrosion*, **10** [8] 37 (1935).—A construction is described which prevents, by a system of interior lubrication, the "freezing" of the valve if it is used for gases or liquids under high pressure and with corroding liquids attacking the lubricant. M.H.

Metallic grouting, its application on hospital-room operating floors. ANON. *Keram. Tile Jour.*, **7** [7] 6 (1935).—It has been supposed that ceramic tile, being a nonconductor of electricity, presented an explosive hazard by building up charges of static electricity in floors constructed of tile. In an investigation of this problem, a metallic grouting was developed, consisting of Portland cement with a proportion of fine brass powder, which is said to effectively dissipate any electrical charges which may be set up in tile floors. M.C.S.

Scientific manufacture of a ceramic building material: IX–XI. F. CHALAMEL. *Rev. mat. constr. trav. pub.*, No. 309, pp. 85–86*B*; No. 310, pp. 100–104*B*; No. 311, pp. 118–20*B* (1935).—Practical directions for plants are given on the chemical analysis, petrographic examination, mechanical analysis, ceramic tests, and preparation of coloring materials; different formulas for colors are given. The preparation of mixes and types of mixes composed of vitrifiable clays are described. For Parts V–VIII see *Ceram. Abs.*, **14** [9] 223 (1935). M.V.C.

Terra cotta defended. ECKARDT V. ESKESEN. *Bull. Amer. Ceram. Soc.*, **14** [11] 381–82 (1935).

PATENTS

Bedplates for the manufacture of roofing tile. W. S.

POWEL AND F. HILL. Brit. 434,908, Sept. 25, 1935 (Oct. 12, 1934).

Method and composition for producing a cold glaze on building materials. V. P. KRAUSS (American Kerament Corp.). U. S. 2,019,981, Nov. 5, 1935 (March 5, 1932).

Method and composition for producing a cold glaze having a dispersing agent therein. V. P. KRAUSS (American Kerament Corp.). U. S. 2,019,980, Nov. 5, 1935 (March 5, 1932).

Process of coloring brick. W. S. DAMHORST. U. S. 2,020,137, Nov. 5, 1935 (June 15, 1933). A process of coloring brick comprises mixing coloring chemicals such as manganese, metallic red, and powdered zinc and fireclay dust with a fine grade of sand, wetting the cavity walls of a brick-forming mold of the type used in connection with the sand-mold process of making soft-mold brick, covering the wet cavity walls of the mold with a relatively thin coat of the fine sand and color mixture by wetting the mold and applying the mixture to the cavity walls while the walls are wet and mixtures dry, forcing plastic clay into the mold cavity under heavy pressure, forming brick thereof and at the same time by the pressure thus forcing the coating of sand and color mixture from the cavity walls into the adjacent surfaces of the plastic brick, removing the plastic brick to a drying pallet and to a drier, drying the brick, placing the dry brick in a kiln in tiers and stacks in varied space relation and varied relative position to provide varied face surface exposures to fire to secure variations in face colorings, and then firing the brick in the kilns.

Roofing tile. E. PORTER. Brit. 434,389, Sept. 11, 1935 (Nov. 24, 1934).

Tile-wall construction, etc. G. E. BORN (Bocjl Corp.). U. S. 2,016,918, Oct. 8, 1935 (Jan. 19, 1933).

Wall or base tile. N. P. CURRIE (Mosaic Tile Co.). U. S. 2,018,201, Oct. 22, 1935 (Dec. 20, 1932).

Wall, floor, ceiling, fireplace, and like tile. T. & R. BOOTE, LTD., AND C. G. M. BOOTE. Brit. 434,297, Sept. 11, 1935 (June 15, 1934).

Whiteware

Analytical method of determining the lead solubility of earthenware glazes using dithizone. W. WEYL AND H. RUDOW. *Ber. deut. keram. Ges.*, **16** [6] 281–86 (1935).—Dithizone (diphenyl-thiocarbazone) is a derivative of thiourea and forms colored complexes with many heavy metals, these complexes being soluble in carbon tetrachloride. Thus it is possible to extract the metal, and the metal dithizonate formed can be determined either colorimetrically or gravimetrically. Absorption spectra of the more important metal dithizonates have been determined. In this method, the following reagents are necessary: a solution of dithizone in carbon tetrachloride; silver nitrate solution (1 g. per 1000 cc.); nitric acid (about 7%); 5% KCN solution and 0.5% KCN solution. Preparation of the solution of dithizone is described. Seven glazes were tested with 4% acetic acid and the new method was used in determining their lead solubilities. A comparison of the results with the chemical composition of the glazes shows that the lead solubility is not dependent on the lead content. The effect of repeated use on the lead solubility was also tested. Ten tests were carried out on a high-lead and a low-lead glaze. Following the first treatment with acetic acid, there is a sharp decrease in the quantity of lead released by the glaze but subsequent tests show only small reduction; in the tenth test the amount of lead determined is still about half of that obtained from the first test. E.J.V.

Continuous process proves advantageous in spark-plug manufacture. A C SPARK PLUG CO. *Ceram. Ind.*, **25** [4] 187–88 (1935).—Data accumulated after operating the continuous system in the clay-forming department (*Ceram. Abs.*, **14** [6] 145 (1935)) for ten months show improved quality, saving in time, and increased efficiency. Changes made include a device on the continuous filter to control the vacuum to within 1 in. of requirements, a change in the operation of the cutter so that only compressed air is used in actuating it, and installation of copper pipe in place of iron pipe in the clay-forming department. Illustrated. E.J.V.

De-airing pottery bodies. OTTO MANFRED. *Ber. deut. keram. Ges.*, **16** [3] 128–29 (1935).—Results obtained by various investigators on de-airing fine pottery bodies are discussed. E.J.V.

Effect of direct gas firing on porcelain glazes. A. P. WATTS. *Ceram. Age*, **23** [2] 37–49 (1934).—Fifty-eight porcelain glazes were direct-fired in an oxidizing furnace atmosphere composed of the products of combustion plus excess air. Forty-one of the glazes were obtained from seven New Jersey plants, and 17 were prepared in the laboratory of the Dept. of Ceramics of Rutgers University. All except 5 were of the one-fire type, and a wide range of colors was represented. The types of ware to which the glazes were applied were electrical porcelain and sanitary porcelain. The maturing temperature of the single-fire ware ranged from 2300° to 2400°F. The two-fire ware matured at 2130°F. The firing time varied between 4 and 8 hr., depending upon the maturing temperature of the glaze and the size of the specimens. The specimens were allowed to cool inside the furnace, approximately 12 hr. being required, thereby making the total time 16 to 20 hr. Results of the direct-firing tests indicate that (1) both white and colored porcelain glazes can be direct-fired without damage to either body or glaze, (2) flashing or direct impingement of flame against the glaze surfaces must be prevented to obtain successful results, and (3) a material reduction in firing time can be obtained without damage to body or glaze. F.G.H.

Fusibility and expansion of porcelain and stoneware glazes fusing around 1280 to 1300°C. P. BRÉMOND. *Céramique*, **38** [566] 101–108 (1935).—B. gives tables of results of tests on the fusion point of cone 9 to 10 porcelain glazes. The effect of Al_2O_3–SiO_2 ratio, alkaline earth oxides, borax, metallic oxides, and sodium and potassium oxides on the expansion of the glaze is discussed. M.H.B.

Heat treatment of electrical porcelain. E. H. FRITZ. *Penn. State Coll. Mineral Ind. Expt. Sta. Bull.*, No. 14, pp. 77–83 (1933).—Heat treatment in the manufacture of

electrical porcelain is important because the ability of electrical porcelain to insulate electrically is completely dependent upon proper vitrification. Vitrification was first improved by more careful control of firing, *e.g.*, the redesign of kilns, installation of dampers, control of draft, change in fireboxes, etc. A further improvement was made by decreasing the particle size of the feldspar. This decreased the porosity (eliminating faulty insulators on a transmission line) and improved the mechanical and impact strength. The improvement of the thermal-shock characteristics was effected by carefully controlling the cooling of the insulators, especially below 650°C. Experiments are described and references to the literature are cited showing that rapid cooling at first and then gradually slowing down until comparatively slow cooling was obtained through the critical range of quartz inversion produced a mechanically strong porcelain. One theory is advanced that the cause of the increased strength is due to the fact that extremely rapid cooling retards the development of crystal growth. Another theory is that the increased strength might be due to the development of internal strains within the porcelain. H.E.S.

Kaolin-quartz-feldspar system after heat treatment. T. NAKAI AND Y. FUKAMI. *Jour. Soc. Chem. Ind.* [Japan], **38** [7] 342–44*B* (1935).—The results of an examination of 80 samples prepared from kaolin-quartz-feldspar mixtures to determine their true densities by the X-ray method are given. M.V.C.

Leeke, first Australian potter. T. CAMPBELL. *Clay Prod. Jour. Australia*, **2** [11] 5 (1935).—When the first fleet arrived in 1788, suitable clay was found near Sydney Cove, and a potter among the convicts named Elijah Leeke, was given the requisite tools and set to work. H.H.S.

One-fire sanitary ware. J. B. NEALEY. *Ceram. Age*, **23** [3] 73–75 (1934).—The production of one-fire sanitary ware is briefly described. Firing of ware in a gas-fired car-type tunnel kiln at 2200°F is discussed in detail. Illustrated. F.G.H.

Science and the dinner plate. ANON. *Discovery*, **16**, 204–206 (July, 1935).—An account of china manufacture is illustrated by micrographs of glaze and body. H.H.S.

Shaping ceramic mixes by casting. ALIX CORNILLE. *Rev. mat. constr. trav. pub.*, No. 312, pp. 129–33*B* (1935).—Observations on the preparation of the slip and body in the production of ordinary porcelain, especially to show the differences which exist between laboratory and factory production, are given. M.V.C.

Softening of porcelain bodies under pressure. ADOLF HEINZ. *Sprechsaal*, **68** [32] 495–98; [33] 511–15; [34] 525–26; [35] 537–40 (1935).—From experiments on the softening under pressure, the softening behavior of porcelain bodies was studied to determine the stability. Stability depends on (1) composition of the body, (2) shaping, (3) firing temperature, (4) particle size of raw materials (especially quartz), and (5) viscosity of the glass phase. The particle size of the raw materials and viscosity of the glass phase are in the closest relationship because of melting and dissolving phenomena. If the particle size of quartz, which must always be kept in such limits that it will not present difficulties on working, is large, it will resist the dissolving action of feldspar much better than finely ground quartz. As a result, through the formation of a melt poor in silica but rich in alumina, the values of the viscosity of the melt increase greatly and through this raise the stability. As the softening temperatures show, it is through the softening under pressure that the viscosity of fired porcelain bodies can be measured and conclusions drawn with regard to stability. M.V.C.

Special ceramic mixes. MARCEL LÉPINGLE. *Verre & Silicates Ind.*, **6** [19] 357–59 (1935).—The characteristics of (1) aluminum oxide, (2) corundum, (3) spinel, (4) beryllium oxide, (5) zirconium oxide, (6) magnesium oxide, (7) thorium oxide, and (8) zirconium silicate, for special ceramic mixes for the laboratory and electrical and chemical industries, are given. M.V.C.

Specific gravity as an index for slip control. J. R. BEAM. *Bull. Amer. Ceram. Soc.*, **14** [10] 333–35 (1935).

Surface resistivity of absorbed moisture films on glazed porcelain. F. W. JOHNSON. *Phil. Mag.*, **18**, 63–80 (1934).—A preliminary discussion is given of the factors effecting the formation of electrically conducting moisture films on solid insulating surfaces and the influence of these films both on the resistivity of the surface and the alteration of the electrical stress distribution in high-voltage fields. Most of the work in this field has been done with direct current. Experimental results are reported on glazed porcelain in which curves showing the variation of surface resistivity with time of applied alternating voltage and with relative humidity are presented. E. M. GUYER

Talc for use in electrical porcelains. FRANK J. FALLON. *Ceram. Ind.*, **25** [4] 201–204 (1935).—Steatite porcelains are superior to other electrical porcelains except in thermal expansion, and by combining the proper ingredients so that the main constituent formed on firing is cordierite ($2MgO{\cdot}2Al_2O_3{\cdot}5SiO_2$), a very low coefficient of thermal expansion can be obtained. By varying the percentage of talc in an electrical porcelain almost any desired property can be obtained. The geological formation, properties, and characteristics of talc are discussed. A review of the literature on steatite compositions shows that authorities agree to (1) mechanical toughness, (2) high dielectric values, (3) high density, and (4) accuracy of dimensions due to low shrinkage. Suggestions for further study are presented. E.J.V.

Whiteware industry permanent recovery. A. S. WATTS. *Ceram. Age*, **24** [1] 5–6 (1934).—The following projects are suggested to insure the recovery of the whiteware industries: (1) promote a standard classification of whiteware with Federal recognition; (2) investigate the possibilities of more expensive decorations in regard to increased market; (3) investigate the proposed plan for advertising American tableware; (4) promote a study of American *vs.* European tableware; and (5) investigate the merits of coöperative research as a means of solving the problems common to the entire industry. F.G.H.

BOOK

Grading and polishing of porcelain ware. V. I. ELISEYEV AND V. I. BOGATIRYOV. State Pub. House of Light Ind., Moscow, 1935. 56 pp. Price 55k. This brochure deals with porcelain manufacture, classification of defects

of household porcelain, requirements for porcelain ware, and its grading, polishing, and transport. S. I. PERKAL

PATENTS

Flush tank. W. A. HENN. U. S. 2,016,635, Oct. 8, 1935 (April 4, 1934).

Manufacture of articles of porcelain and stoneware. G. FUSCHI AND M. KORACH. Brit. 434,494, Sept. 18, 1935 (Feb. 27, 1934).

Means for handling frangible tile, etc. WALTER PURSELL AND E. C. GAERTNER. U. S. 2,017,571, Oct. 15, 1935 (Aug. 31, 1933).

Metal-refractory joint. J. E. LILIENFELD (Ergon Research Laboratories, Inc.). U. S. 2,015,483, Sept. 24, 1935 (June 29, 1932).

Method of effecting metal-refractory joint and joints resulting therefrom. J. E. LILIENFELD (Ergon Research Laboratories, Inc.). U. S. 2,015,482, Sept. 24, 1935 (June 29, 1932).

Method of effecting metal-glazed-refractory insulator joint and joints resulting therefrom. J. E. LILIENFELD (Ergon Research Laboratories, Inc.) U. S. 2,015,484, Sept. 24, 1935 (June 29, 1932).

Method for treating glazed ceramic ware. WILLIAM McCOY. U. S. 2,017,318, Oct. 15, 1935 (Oct. 6, 1931). A method of treating finished glazed ceramic ware consists in incorporating in such ware, after it has been kiln-fired, an inorganic salt having the property of inhibiting crazing of the glazed surfaces of the ware when the latter is in juxtaposition to a moisture-containing body.

Porcelain resistant to the passage of X-rays and method of making. LESLIE BROWN (Lenox, Inc.). U. S. 2,018,600, Oct. 22, 1935 (May 15, 1935). A process of preparing a porcelain relatively resistant to the passage of X-rays comprises heating together a reactive lead compound, an acidic oxide, and a relatively small amount of a heat-decomposable alkali metal salt to form a vitrified calcine of relatively high melting point, adding the calcine to a porcelain mix, and thereafter pressing the mixture in finely divided form to the desired shape and firing the shaped object to cause vitrification thereof.

Spark plug. O. C. ROHDE (Champion Spark Plug Co.). U. S. 2,020,965, Nov. 12, 1935 (Jan. 25, 1934).

Spark plug and method of making. O. C. ROHDE (Champion Spark Plug Co.). U. S. 2,020,966, Nov. 12, 1935 (Feb. 9, 1934) and U. S. 2,020,967, Nov. 12, 1935 (Sept. 21, 1934).

Toilet bowl. W. A. HENN. U. S. 2,016,636, Oct. 8, 1935 (April 4, 1934).

Equipment and Apparatus

Accurate measurement of high gas temperatures. H. F. MULLIKIN. *Power*, **78** [10] 565 (1934).—A "high-velocity" thermocouple has a heat-insulating shield around the tip. A stream of hot gases is aspirated past the junction of the thermocouple at a high velocity. Heat transfer from the gas to the thermocouple tip is increased, thereby causing the reading to approach closely the true gas temperature. Illustrated. F.G.H.

Agitation: I, Suspension of sand in water. A. M. WHITE, S. D. SUMERFORD, E. O. BRYANT, AND B. E. LUKENS. *Ind. Eng. Chem.*, **24**, 1160 (1932).—In the case of an insoluble solid in a liquid, maximum suspension of the solid is attained after a very short period of agitation. Uniformity of concentration of the suspended solid is never obtained but is approached more closely when the paddle is near the surface of the liquid than when it is close to the bottom of the tank. Maximum suspension of the solid is obtained when the paddle is near the bottom of the tank, although the liquid above the stirrer is low in suspended matter. There is a hydraulic sizing of particles in the tank. The large particles remain on the bottom near the center of the tank, whereas the small ones are carried into suspension by the flow of the liquid. Sand concentration does not indicate the stream flow of the liquid, although it is probably a practical measure of its velocity. **II, Sand concentration as function of sand size and agitator speed.** A. MCLAREN WHITE AND S. D. SUMERFORD. *Ibid.*, **25**, 1025–27 (1933). **III, Simple agitator as a classifier.** *Ibid.*, **26**, 82–83 (1934). **IV, Power measurements.** A. M. WHITE, E. BRENNER, G. A. PHILLIPS, AND M. S. MORRISON. *Trans. Amer. Inst. Chem. Engrs.*, **30**, 570–85 (1934).—Despite the widespread and long-continued use of mixing and stirring machinery, the design of equipment of this type still remains almost wholly empirical. Previous data have indicated qualitatively that power demand increases rapidly with higher rotational speed. This paper reports results on measurements of power consumption by simple paddle stirrers. **V, Correlation of power data.** A. M. WHITE AND E. BRENNER. *Ibid.*, pp. 585–98.—The data presented in the preceding part are applied to evaluation of the unknown constants for the region of turbulent flow in the dimensional equation relating power with the variables significantly affecting the power consumption of a single paddle agitator,

$$\frac{P}{\rho N^3 L^5} = K\left(\frac{Z}{L^2 N \rho}\right)^a \left(\frac{W}{L}\right)^b \left(\frac{H}{L}\right)^c \left(\frac{D}{L}\right)^d$$

where Z is absolute viscosity, N agitator speed, L paddle length, W paddle width, D tank diameter, H liquid depth, ρ liquid density, K, a, b, c, d experimentally determinable constants, and P the power absorbed by the stirrer. Paddle thickness and the distance of the paddle from the bottom of the container have negligible influences on the power consumption. Roughness plays an important (but difficult to evaluate) rôle. The equation fitting the experimental data is $P = 0.000129 L^{2.72} Z^{0.14} N^{2.88} \rho^{0.86} D^{1.1} W^{0.2} H^{0.4}$, where the units are P in horsepower, N revolutions per second, Z lb. per sec.-ft., ρ lb. per cu. ft., and all length terms are in feet. A.P.

Aids for testing materials. H. F. LOEWE. *Emailwaren-Ind.*, **12** [18] 145–46 (1935).—A method for investigating materials by means of a new type of quartz lamp is described. M.V.C.

Apparatus for measuring the drying power of the atmosphere. JOHN R. BAKER. *Jour. Sci. Instruments*, **12** [7] 214–16 (1935).—B. describes the Xerometer, which

gives direct readings of saturation deficiency without calculation, and a nomogram which gives the saturation deficiency without calculation. For data, the nomogram requires the temperature and relative humidity. The "Xerometer," or rate-of-drying meter, is a modification of Casella and Co.'s thermohydrograph. The charts mentioned in the paper are made by that company. Illustrated. J.L.G.

Automatic control of metallurgical furnace conditions. H. J. VELTEN. *Instruments*, **7** [3] 42–44 (1934).—Automatic control of furnaces has ordinarily been applied only to a single condition, such as furnace pressure control, and comparatively few installations have been made in which fuel-use rate, furnace atmosphere, and furnace pressure have been simultaneously regulated. Methods for effecting such control are briefly described; their use should result in substantial fuel savings and better product. R.W.R.

Automatic optical pyrometer. MINNEAPOLIS-HONEYWELL REGULATOR CO. *Instruments*, **8** [10] 271 (1935).—The "Optimatic" optical pyrometer utilizes a narrow waveband at the red end of the spectrum and performs automatically the work of the disappearing-filament optical pyrometer. Characteristics include constancy of calibration, ruggedness, and accuracy. This pyrometer consists of (1) a water-cooled optical telescope which picks up monochromatic light emitted by a moving hot body or from a furnace, (2) a power supply and amplifier unit for either 25 or 60 cycle a.c., and (3) a standard milliampere recorder, or indicator, or both. Temperatures are recorded in less than half a second. Recorder and indicator are of standard make, and critical damping has been secured, so that temperatures of hot moving bodies may be measured. Two photocells, mounted in the telescope, are used; one is exposed to light from the hot body and the other is automatically illuminated by a standard lamp, the current in the lamp circuit measuring the temperature. Both cells are maintained at the same temperature, and the pyrometer is not affected by voltage variations over a wide range. R.W.R.

Automatic spraying of clayware. EARL PAGETT. *Brick Clay Rec.*, **87** [3] 96–98 (1935).—P. describes a mechanism employing an electromagnet and an electric timer in connection with a spray gun to provide for automatic spraying of clayware on a conveyer belt. Difficulties encountered and overcome are listed. Illustrated. E.J.V.

Calibrating radiation pyrometers using part of the radiation by means of the band lamp. R. STECK. *Stahl & Eisen*, **55** [27] 737–39 (1935).—Many radiation pyrometers show inaccurate results after having been used for some time. These may be traced to optical and mechanical factors, *e.g.*, the deposition of dust, etc. A simple device for calibrating such instruments is presented which keeps the instruments under control permanently. W.M.C.

Centrifuge, a working apparatus for ceramic raw materials. E. ERMESCU. *Sprechsaal*, **68** [27] 422 (1935).—Experiments made with a laboratory centrifuge to separate slips and sands are discussed. Tests were made with kaolins and clays. M.V.C.

Centrifuge microscope. GUSTAVE FASSIN. *Instruments*, **8** [6] 142 (1935).—The Harvey-Loomis centrifugal microscope (Bausch & Lomb Optical Co.) consists of a rotor composed of two disks of high tensile-strength aluminum alloy enclosed within a chromium-plated and polished guard to reduce wind resistance. Inside the rotor are two microscope objectives with a right angle reflecting prism in the center. Magnifications obtained with a 10× eyepiece are 100× and 400×. The rotor is driven by a special electric motor at 10,000 r.p.m., corresponding to approximately 4 miles/min., or an outward pull of 750 lb., equal to 12,000 times gravity. Specimens are mounted in a special glass slide. The rapid succession of light impulses through the rotor and a slit in the guard give the impression of a continuous image when observed through the microscope eyepiece. R.W.R.

Color comparator. GENERAL RADIO CO. *Instruments*, **8** [10] 277 (1935).—A new color analyzer has been developed by Barss, Knobel, and Young. Reflection is measured in three frequency bands selected from the complex wave form by filters. The sample is placed over the viewing aperture and milliammeter readings are obtained, corresponding to the red, blue, and green regions. When these readings are identical for two samples, the samples are identical in hue, saturation, and brilliance and will match under any conditions of lighting when viewed by reflected light. No amplifiers are required, and the meter scale is wide and open, permitting determination of small color differences. This instrument is operated directly from the a.c. mains, a voltage regulator being built into the instrument. Power consumption is 75 watts; dimensions 16 x 12 x 12 in.; net weight 40 lb. R.W.R.

Control of heat-technical quantities. J. KRÖNERT. *Arch. Tech. Mess.*, **5** [50] *T*109–10 (1935).—The principles of measuring pressure, draft, temperature, and other quantities required for controlling these factors are discussed, and methods and their theoretical fundamentals are explained. M.H.

Crushing and grinding appliances. Connection between type and purpose. B. W. HOLMAN. *Trans. Inst. Chem. Engrs.* [London], **12**, 186–97 (1934).—Appliances for size reduction are classified according to (1) size of feed, (2) mode of application of the force, and (3) design of appliance. Factors of importance in the choice of an appliance are (*a*) size and classification of particles required, (*b*) effect of iron from the grinding medium on the product, (*c*) moisture content, (*d*) shape of particles required, and (*e*) maintenance and operation costs. Data are given on the capacity, power consumption, and ratios of reduction for a number of crushing and grinding appliances. G.H.A.

Determination of fineness in the range 1 to 100 microns on the basis of Debye-Scherrer photographs. H. S. SCHDANOW. *Z. Krist*, **90**, 82–91 (1935).—A determination of the number of "interference flecks" in a single interference ring of a Debye-Scherrer pattern for preparations containing particles more than 1 micron and less than 100 microns in diameter can be used for the evaluation of grain size. An equation is given relating the number of interference flecks in the pattern to the number of particles per unit volume in the preparation and also giving the value of the proportionality coefficient. A graphic method for approximate calculation of the proportionality coefficient from dimensions of the camera diaphragm and the

size of the median interference flecks for discoidal preparations is given. The method has been used successfully in calculating the size of copper grains after re-crystallization at different temperatures. H.I.

Drying clay by the coagulating effect of acid. H. H. Macey. Presented at joint meeting of Chem. Eng. Group and Yorkshire Section of Soc. Chem. Ind., Brit. Refrac. Research Assn., and Refrac. Section of Ceram. Soc., April, 1935, Sheffield, England. Preprint, pp. 9–19. M. discusses work of previous investigators on the use of electrolytes in overcoming drying troubles (cracking). Fifteen English fire clays and nine brick clays were tested, using HCl. M. conducted sedimentation tests to determine the amount of acid required to produce maximum coagulation as indicated by the time for the clay to settle from a suspension. Drying tests were then made on three full-size brick using a different amount of acid in each brick. Following this, drying tests were made and the results plotted as shrinkage *vs.* moisture content. Additional tests were made to determine the amount of free alkalis, effect of other electrolytes, and the effect of the acid on other properties of the clay such as scumming, firing shrinkage, rate of drying, and amount of tempering water required. M. found that all clays except three could be made to settle within 25 min. by acid treatment, although three clays settled rapidly without acid. Amounts of acid required for maximum coagulation varied with different clays, but did not exceed 0.25% of the weight of the clay. With some clays, rate of settling increased fairly uniformly to maximum with added amounts of acid. With others, an abrupt change in the rate of settling occurred with only a small change in the amount of acid. Clays of this type will be aided most in prevention of cracking by an acid treatment.

A severe hot plate-forced air drying test was used to determine the effect of acid in preventing cracking. Results on typical cases are shown by drawings. The results of the sedimentation test were found to be sufficiently accurate to determine the amount of acid required. With five clays the effect of acid was very beneficial; with ten others the tendency toward cracking was reduced; with seven others no effect was found; with one clay cracking was definitely increased.

M. found that the use of acid was more effective with fire clays than with brick clays. The optimum amount of acid caused primary drying shrinkage to cease at a higher moisture content and total drying shrinkage to be less with one or two exceptions. The amount of benefit in preventing cracking derived from the acid is connected with the degree of change in shrinkage and not its absolute magnitude. Other salts and acids were not found to be as effective as HCl. The use of acid, except in large amounts, did not produce scum. Firing shrinkage tends to increase with the use of acid. The rate of drying under definite conditions is slightly reduced when acid is used and is attributed to a decrease in the vapor pressure of water. Very little difference was noted in the amount of tempering water required for a given consistency when acid was used. M. questions the seriousness of the corrosion of metal in the machinery used for handling plastic clay treated with acid. With one clay acid tended to decrease the amount of bloating when fired rapidly.

M. concludes that the effect of acid varies greatly from clay to clay, and will be quite beneficial in preventing cracking in some clays and not in others. The sedimentation test indicates whether the use of acid will be beneficial and the amount to use. The action of the acid in preventing cracking is due to the opening up of the water channels. When acid is effective, the amount required is not large. There is no tendency for the effect of the acid to be nullified by the firing. See also "Principles—" *Ceram. Abs.*, **13** [8] 224 (1934). J.L.C.

Drying machinery. T. J. Horgan. Presented at joint meeting of Chem. Eng. Group and Yorkshire Section of Soc. Chem. Ind., Brit. Refrac. Research Assn., and Refrac. Section of Ceram. Soc., April, 1935, Sheffield, England. Preprint, pp. 20–34. H. discusses the ordinary phenomena involved in drying and drier design. He states that extensive laboratory or semicommercial drying tests must be used in addition to theoretical analysis of drying problems and that the results must be correctly interpolated to insure correctly designed equipment. Various types of rotary driers, such as the single shell, double shell, louvre, and "Allen-Buell" (Buttner system) are described and some operating results for materials other than clays are given. Several modifications of the Allen-Buell turbo driers (Buttner system) are described. This drier has a unique air-circulating system. Generally the air enters at atmospheric temperature, is recirculated through the charge and heating elements, and finally leaves the drier at maximum temperature and humidity at the point where the wet material enters the system. Circulation is obtained by specially designed slow-moving turbine fans. The air moves counter to the direction of material flow and the material receives some cooling before leaving the drier. Various arrangements are used for conveying the material through the drier. Driers for filtered material, fiber boards, loose fibers, hanks, and fabrics are described and illustrated. J.L.C.

Drying research in Department of Ceramic Engineering, Ohio State University. J. L. Carruthers. *Ceram. Age*, **23** [2] 52 (1934).—A program is outlined which covers the investigation of physical properties of numerous clays, determination of the drying characteristics of the clays under definite and controlled conditions, determination of the rates of heat transfer and water diffusion through plastic clay bodies, and the application of the data obtained to the design of drying systems. F.G.H.

Drying solid materials: IX, Retarded rate of drying. X, Temperature of the sample. Saburo Kamei. *Jour. Soc. Chem. Ind.* [Japan], **38** [8] 407–11*B* (1935). **XI, Drying of alumina.** S. Kamei, S. Midzuno, and S. Shiomi. *Ibid.*, pp. 411–16*B*.—Relationships between the various kinds of alumina and the rate of drying are discussed. **XII, Shrinkage on drying of clay samples. XIII, Surface coefficient and critical water content of clay on drying. XIV, Drying of soap.** *Ibid.*, **38** [9] 456–73 (1935).—The results are shown in curves. For Parts VI–VIII see *Ceram. Abs.*, **14** [5] 122 (1935). M.V.C.

Dry working of ceramic mixes. A. Primakovskiĭ. *Novosti Tekhniki*, No. 15, pp. 15–16 (1934); abstracted in *Referat. Silikatliteratur*, No. 593 (1934).—The new method consists in (1) a dry grinding of the thinning agents with their separation in separate fractions; (2) dry grind-

ing of the plastic material, and (3) dry mixing of the pulverized plastic and thinning materials. The ware is fired to 1550°, producing vitrified bodies. M.V.C.

Effect of the solid-liquid ratio on grinding a ceramic nonplastic. KARL SCHWARTZWALDER AND PAUL G. HEROLD. *Jour. Amer. Ceram. Soc.*, **18** [11] 350–52 (1935).

Electrohydraulic temperature regulator. WILBIN INSTRUMENT CO. *Instruments*, **8** [1] 24 (1935).—This apparatus uses the thermal expansion of a liquid to move a contact arm over several contacts. An oil-operated valve periodically opens or closes to an extent determined by the position of the contact arm. This equipment may be used to regulate flow of steam, oil, gas, water, or brine at desired temperatures between −40°F and 950°F. R.W.R.

Eliminating lamination in brick. ERNEST W. KNAPP. *Brick Clay Rec.*, **87** [3] 82–84 (1935).—Lamination is due primarily to (1) friction of the clay on metal, slowing up the flow of that part of the clay stream adjacent to the metal and allowing the core to slide faster, the lamination being the plane of slippage between the two; and (2) the necessity of tapering down the clay wad from auger diameter to the die opening to obtain sufficient density to form the shape. In solving the problem, it would be necessary to design a die and auger arrangement that would practically eliminate the tendency of the clay to accumulate unequal density and to slip upon itself. It would be necessary to depend on a high vacuum to a considerable extent for creation of sufficient density in the bar. Electrical lubrication of the die should be developed further. E.J.V.

Errors in measuring temperature by thermocouples. H. EULER AND K. GUTHMANN. *Arch. Eisenhüttenwesen*, **9**, 73–90 (1935).—Errors in temperature measurements may be caused by (1) high resistance of the wires used in the thermocouple circuit, (2) poor contact at the binding posts of the couple and the measuring instrument, (3) temperature increase of the cold junction (to be compensated by special wires), (4) errors in mounting the couple, such as great conduction and radiation of heat, (5) aging of the wires of the thermocouple (to be improved by annealing the wires), (6) chemical impurities, (7) corrosion by the atmosphere surrounding the couple (particularly presence of sulfur), (8) appearance of additional electric currents caused by poor contacts or by the insertion of metals different from those contained in the couple, and (9) incorrect reading of the indicating or recording instrument (to be avoided by a permanent supervision and checking of the instrument). The best means of avoiding errors is the arrangement of protecting tubes around the thermocouples which will not react with them. Almost all the errors mentioned tend to bring about too low an indication of the temperature, *i.e.*, the true temperature will be higher than that indicated by the couple. W.M.C.

Extensometer comparator. AMBROSE H. STAND AND LEROY R. SWEETMAN. *Jour. Research Nat. Bur. Stand.*, **15** [3] 199–203 (1935); R.P. 822. Price 5¢.—An extensometer comparator for the calibration of extensometers, compressometers, micrometer dials, and strain gages is described. The comparator has given satisfactory results in calibrating length-measuring instruments used for materials testing. Gage lengths of from 1/4 to 24 in. can be calibrated. R.A.H.

Fundamental principles of drying. E. A. FISHER. Presented at joint meeting of Chem. Eng. Group and Yorkshire Section of Soc. Chem. Ind., Brit. Refrac. Research Assn., and Refrac. Section of Ceram. Soc., April, 1935, Sheffield, England. Preprint, pp. 3–8. F. reviews quite thoroughly the external factors of drying, *i.e.*, rate of evaporation of water, velocity and direction of air flow, humidity, and method of heat transfer. The fundamental requirements in drier design are (*a*) supply of heat for evaporation, (*b*) sufficient air to sweep away the vapor, (*c*) control of temperature and humidity to protect the product from injury, and (*d*) sufficient time for escape of moisture. External drying factors govern *a*, *b*, and *c*. Internal factors affecting rate of water movement govern *d*. Rates of water movement and evaporation must be correctly balanced to prevent cracking. Under constant drying conditions, the rate of drying curve generally consists of four distinct portions, three linear and one curved. The number of portions depends upon original moisture content and thickness and character of the material. They are (1) constant rate period, (2) falling rate period (external drying factors govern in first two periods), (3) falling rate period (water movement governing) and (4) decreasing rate period (seldom used in commercial drying since it applies to equilibrium moisture). Equations for the three linear portions are given. F. explains the first falling rate periods as due to decreasing area for evaporation and reduction of vapor pressure of moisture as larger pores empty. In the third period, the water movement is a function of slab thickness and the factors governing the movement of the liquid and the vapor. In this period, evaporation also tends to occur within the solid. The work of Sherwood on rates of drying is also discussed. J. L. C.

Furnace temperature and heating-rate control by dilating wire. T. C. EDDY, F. W. VIGELIUS, AND E. C. EDDY. *Instruments*, **8** [7] 174–76 (1935).—A constant rate of increase in temperature of an electric furnace may be secured by the use of a "dilating wire" within the furnace. The heating current passes through this wire, which is in series with the heating coils of the furnace and a (reversing) motor-operated power rheostat. The wire is surrounded with a glass tube so that most of its heat loss is by radiation. Changes in length of the dilating wire actuate a contact arm within a coaxial two-segment commutator, causing the power rheostat to increase or decrease the heating current. The commutator is rotated by a synchronous motor at a very low rate of speed, the exact speed being determined by the rate of temperature rise desired. For each rate of temperature rise, the initial current should be adjusted to the right value by initial adjustment of the power rheostat. In this investigation, a 24-in. length of No. 24 B. & S. gage wire was used; no great difference in performance was found between Advance and Nichrome V. Temperature-time curves for a furnace controlled by this method are nearly linear. Diagrams of the apparatus and set-up are given. R.W.R.

Gallium thermometers. PRAKTIKUS. *Glas & App.*, **16** [19] 178 (1935).—The replacement of Hg in thermometers up to 1000°C by Ga which boils at 2000° and freezes at 27°C was tried, but no satisfactory solution has been found; in spite of the extreme purity of the Ga used there

remained always a black residue in the capillary. Further research is recommended since a Ga thermometer would not need filling under high pressure as does the Hg thermometer with the N atmosphere in the capillary. M.H.

Griesemann vacuum press for de-airing plastic ceramic mixes. A. COULHON. *Rev. mat. constr. trav. pub.*, No. 311, pp. 113–17*B* (1935).—C. describes the press, vacuum chamber, motor power, cleaner, and divider. De-aired mixes have a regular structure and are without scales or bubbles. Pipes can be drawn out for 6 m. without breaking. In spite of their plasticity and malleability, de-aired mixes are very rigid and hold their shape; they contain less moisture than normal mixes and are less porous. The mechanism of drying is explained. Further advantages of de-aired mixes are given. M.V.C.

High index refractometer. R. C. EMMONS AND E. F. WILLIAMS. *Jour. Sed. Petrology*, **4** [1] 32–35 (1934). G.M.H.

Industrial expansion-type pyrometers. R. Y. FERNER CO. *Instruments*, **7** [10] 220 (1934).—This pyrometer is furnished in ranges up to 1000°C and depends on the difference of expansion of a Pyros alloy rod and enclosing fused silica tube. It is supplied in several ranges and in indicating, regulating, and recording types. R.W.R.

Manufacture of helical silica springs. A. KING, C. G. LAWSON, J. S. TAPP, AND G. H. WATSON. *Jour. Sci. Instruments*, **12** [8] 249–52 (1935).—Machines and operating techniques for mechanically drawing fine fibers of quartz glass and for winding the fibers into helical springs are described and illustrated. Calibration and sensitivity of the springs are discussed in detail. J.L.G.

Measurement of the elastic constant of isotropic transparent solids. E. HIEDEMANN. *Nature*, **136** [3435] 337 (1935).—Viewing oscillating cubes of glass in ordinary light and between crossed nicols, H. observed two series of lines, due to longitudinal waves in ordinary light and to transverse waves between crossed nicols. From measurements of the separation of the observed lines and the frequency of the oscillations, he was able to calculate the elastic constants of the glass and obtain results which checked closely with those obtained in other ways. For a glass with an isothermal Young's modulus of 7471 kg./mm.^{2}, a value of 7531 was secured for the adiabatic modulus, using a vibration frequency of 4894 kc. A general accuracy of 1 part in 1000 is claimed for this method. Moreover, an accuracy of 1 part in 10,000 is claimed as possible in determining Poisson's ratio. J.L.G.

Mechanical method for measuring the plasticity of clays and mixtures of clays. J. W. WHITTEMORE. *Jour. Amer. Ceram. Soc.*, **18** [11] 352–59 (1935).

Optical instruments in the study and control of ceramics. EVERETT WHITE MELSON. *Ceram. Ind.*, **24** [5] 260–62 (1935).—Illustrated. E.J.V.

Optical method for mechanical analysis of soils, etc. E. G. RICHARDSON. *Jour. Agric. Sci.*, **24** [3] 457–68 (1934).—The results of attempts to use the transmission of a beam of light through a glass cell as a measure of the sedimentation process taking place within it are described. A photoelectric cell was used to receive the transmitted light. Results from the "constant-time" and "constant-depth" methods showed good agreement. The advantages of this method of analysis are discussed. Its application to the sampling of mineral ores and the measurement of dust in the air in mines is suggested. G.H.A.

Photoelectric colorimeter. TH.-W. SCHMIDT. *Z. Instrumentenk.*, **55** [8] 336–46; [9] 357–67 (1935).—After discussing the subjective and objective types of colorimeters, S. describes a new type which eliminates the errors connected with the other types by using a monochromatic radiation in such a manner that the law of Lambert-Beer with regard to monochromasy is fulfilled. Furthermore, the measurement is independent of the type of photocell used and always gives, for the same wave-length, the same extinction coefficient. The apparatus can be used for routine measurements. Theoretical principles and construction are fully described. M.H.

Photoelectric measuring instruments for absorption, reflection, and turbidity. R. SEWIG. *Arch. Tech. Mess.*, **5** [51] *T*119 (1935).—Principles, measuring arrangements, and types of photocells used for determining the qualities of textiles, papers, gases, and glasses are described. M.H.

Photoelectric reflection meter. PFALZ AND BAUER, INC. *Instruments*, **8** [10] 279 (1935).—Designed by B. Lange of the Kaiser Wilhelm Institute, an instrument for the determination of "whiteness" is distinguished by a combination element in which a central light source and an annular self-generating photocell are always in fixed relation to each other and to the surface of the specimen, so that the photocell output bears a reliable relation to the property under measurement. In addition to reflection measurements, colorimetric analyses may be made with the aid of filters supplied with the outfit, which includes a microammeter for photocell output, a small Edison storage battery, a voltmeter for standardizing the light source, two rheostats, a rectifier, dishes for measurements on powders, and standard black and white plates for determinations of transmissivity and opacity. R.W.R.

Portable chemical balance. H. LLOYD. *Jour. Sci. Instruments*, **12** [7] 222–24 (1935).—L. gives constructional details of a portable, miniature spring balance capable of giving rapid weighings on small samples of material used for chemical analysis. It was developed for weighing 250-mg. steel samples to an accuracy of within 2%. Illustrated. J.L.G.

Resistance of enamels and glazes to shock. L. LONGCHAMBON. *Céramique*, **38** [567] 123–24 (1935).—Surface vitrification, glazes, and enamels are tested for resistance to shock by dropping a weight having a small surface on them. The fracture, if any, and its nature determine the resistance. M.H.B.

Rotary-type sample splitter. C. K. WENTWORTH, W. L. WILGUS, AND H. L. KOCH. *Jour. Sed. Petrology*, **4** [3] 127–28 (1934).—Tests of a rotary splitting machine in large and small form are described. The rotary device was superior to the Jones type on sandy gravel for mechanical composition. On mineral grain mixtures where the size of final samples is purposely restricted, the rotary machine is perhaps slightly better than nonrotary devices, but it is doubtful if much more valid splitting can be expected from any mechanical device because of the limit inherent in statistical theory as applied to small samples. G.M.H.

Screen analyses for plant control. EDGAR W. RUCH. *Jour. Amer. Ceram. Soc.*, **18** [11] 346–49 (1935).

Sedimentation of fine particles in liquids. R. F.

STEWART AND E. J. ROBERTS. *Trans. Inst. Chem. Engrs.* [London], **11**, 124–41 (1933).—The underlying principles of sedimentation are the laws governing the movement of solid particles in a liquid under the force of gravity. This paper discusses (1) the adaptation of Stokes' law to commercial installations, (2) importance of sedimentation principles in particle classification, and (3) application of sedimentation to thickening and clarification. Types of hydraulic and nonhydraulic classifiers are described. Illustrated. G.H.A.

Temperature-limit control for furnace roofs. LEEDS & NORTHRUP CO. *Instruments*, **7** [12] 266 (1935).—Overheating of furnace roofs can be avoided by the use of this apparatus consisting of (1) a silicon carbide block of special design with well drilled to 1 in. of the bottom, which may be installed while the furnace is hot or when the furnace is built; (2) thermotube employing mirror-and-thermocouple principle, with a waterjacket which serves as mounting (no actual contact between thermotube and brick); (3) potentiometric recorder-controller with a range of 1400 to 3200°F; and (4) simple motorized valve. R.W.R.

Time chart for mechanical analyses by the pipet method. W. C. KRUMBEIN. *Jour. Sed. Petrology*, **5** [2] 93–95 (1935).—A double logarithmic chart showing the relations between diameters in millimeters and time in hours for settling a given distance is presented. Details of construction are mentioned. G.M.H.

Vacuum-extruding presses. OTTO MANFRED. *Sprechsaal*, **67** [9] 129–30 (1935).—Construction details of machines used for de-airing clay masses are briefly discussed. Illustrated. M.V.C.

BULLETIN

Dust collectors. ANON. *Pangborn Corp. Bull.*, No. 197, 24 pp.; reviewed in *Ceram. Age*, **24** [1] 28 (1934).—All-metal, cloth screen dust collectors are described. Details are given of installations in various branches of ceramic raw material production, including clays, feldspar, silica, and talc. F.G.H.

PATENTS

Apparatus for feeding paints, enamels, etc., to spray guns. F. E. WEBB. Brit. 436,192, Oct. 16, 1935 (April 13, 1935).

Apparatus for molding clay, etc. J. A. BIDDLE, L. G. PITT, AND H. J. HADEN. Brit. 435,840, Oct. 9, 1935 (Jan. 11, 1935).

Brick mold. C. E. WALKER. U. S. 2,015,980, Oct. 1, 1935 (Sept. 5, 1934).

Method and apparatus for making hollow ceramic ware. C. C. KESTY (Empire Trust Co.). U. S. 2,015,681, Oct. 1, 1935 (Oct. 22, 1932). Apparatus for making hollow ceramic ware comprises means for extruding a column of plastic ceramic material having a longitudinal core space therein and means for indenting the side walls of the column at spaced intervals substantially to close the core space.

Method for fixing metal bodies in workpieces made of porcelain. O. E. W. OSENBERG AND KERBKONUS-GES. Brit. 434,842, Sept. 25, 1935 (June 25, 1934).

Transfer apparatus. J. C. GIPE AND J. P. CROWLEY (Libbey-Owens-Ford Glass Co.). U. S. 2,019,182, Oct. 29, 1935 (April 21, 1932).

Kilns, Furnaces, Fuels, and Combustion

Burning fuel oil. A. G. SOLOMAN. *Power*, **78** [8] 432 (1934).—Practical information on operating precautions for the fireman is given. F.G.H.

Circular kilns and operations at plant of C. C. Thompson Pottery Company. J. B. NEALEY. *Ceram. Age*, **23** [5] 133 (1934).—The operation of a circular biscuit tunnel kiln and straight glost and decorating tunnel kilns in a plant producing semiporcelain dinnerware is described and illustrated. F.G.H.

Circular tunnel kiln at Harker Pottery. J. B. NEALEY. *Ceram. Age*, **24** [1] 7–9 (1934).—A circular tunnel kiln for chinaware production is described and its operating characteristics are discussed. Illustrated. F.G.H.

Circular tunnel kiln saves 63% in fuel. WESTERN STONEWARE CO. *Ceram. Ind.*, **24** [5] 278 (1935).—Installation of a circular tunnel kiln, with open setting of the ware, has resulted in a production equal to approximately $4^1/_2$ periodic kilns and a fuel saving of 63% on a comparative basis. A more uniform temperature is obtained throughout and the firing time has been reduced. Losses have been minimized, and due to the open setting a greater volume of ware can be fired. Illustrated. E.J.V.

Cleaning producer gas lines. J. GAVIN CALLINAN. *Glass Ind.*, **16** [11] 339–41 (1935).—The periodic burning-out of producer gas lines is necessary to economical operation. Factors influencing maintenance of the producer-gas line in the best condition compatible with low burn-out frequency, original design of the line, interim clean-outs, and the periodic burn-outs are discussed. Illustrated. E.J.V.

Coal carbonization—the plastic stage. J. H. LUM AND H. A. CURTIS. *Ind. Eng. Chem., Anal. Ed.*, **7** [5] 327–33 (1935).—The gas-flow test devised by Foxwell for studying the plastic stage in coal carbonization is reviewed. Opinions differ concerning the correlation of the gas pressure-temperature curve obtained in the Foxwell procedure with the condition of the coal during carbonization. Consequently, a study of the following factors which influence the results in the gas-flow test was made: (1) rate of gas flow through the coal charge, (2) packing of crushed coal in the fusion tube, (3) length of coal charge in the fusion tube, (4) screen analysis of the coal used, and (5) rate of heating of the coal as the softening point is approached and during the plastic stage. The Foxwell procedure was standardized with respect to these factors, and the pressure-temperature data obtained upon various coals are correlated with data on their plasticity. The extrusivity of coals in the plastic condition is taken as a measure of their plasticity, and an apparatus for measuring extrusivity is described and illustrated. F.G.H.

Continuous tunnel kiln with methodic heating and integral recuperation for ceramic firing. E. DAMOUR. *Rev. mat. constr. trav. pub.*, No. 310, p. 109*B* (1935).—The air for heating is divided into two currents of equal impor-

tance; one passes through the up tunnel where it is heated by contact with the fired products and the other passes through the regenerator. In both cases the equality of the calorific masses of air is realized and recuperation is integral. For firing at low temperature, however, the calorific mass of air is relatively small; hence the simple tunnel is used. In the opposite case, the by-pass is used and a combination arrangement is adopted. A suction ventilator on the down tunnel may be necessary. M.V.C.

Convection heating equipment. ANON. *Ind. Heating*, 2 [9] 476–92 (1935).—Development in design and construction of convection-type furnaces, *i.e.*, with air circulation, ovens, and their auxiliary equipment are reviewed, and the advantages of this type of heating are explained. Many examples from the steel and ceramic industries are described. M.H.

Design and selection of heat-enduring alloys for industrial furnaces. R. STUART BROWN. *Ind. Heating*, 2 [9] 495–98 (1935).—Principal requirements for such alloys are (1) oxidation resistance so that they last indefinitely at the operating temperature, (2) structural ability, in particular permanent ductility under heat, (3) corrosion resistance against sulfur for use with some fuels, and (4) high-temperature creep strength. Oxidation and corrosion resistance are largely determined by Cr and Ni content; structural ability and creep strength depend almost entirely on the minor elements in the composition and the methods employed for melting and casting. Correct design and use of practical data are discussed. M.H.

Dissociation energy of the CO molecule and the sublimation heat of carbon. P. GOLDFINGER AND W. LASAREFF. *Nature*, 135 [3426] 1077 (1935).—The authors arrive at a value of 167 kcal. for the dissociation heat of carbon from a consideration of the energy of dissociation of CO into normal atoms. J.L.G.

Draft-gage connections that prevent trouble. C. C. PHELPS. *Power*, 78 [12] 672 (1934).—Layout plans for furnace draft-gage lines are described and illustrated in detail. F.G.H.

Economy of electric firing in the ceramic industry. FRANZ HAUTMANN. Translated in *Bull. Amer. Ceram. Soc.*, 14 [10] 342–43 (1935).

Electric firing in the ceramic and glass industries. J. COURTOIS. Translated in *Bull. Amer. Ceram. Soc.*, 14 [10] 344–46 (1935).

Electric firing of white porcelain. H. MASUKOWITZ. Translated in *Bull. Amer. Ceram. Soc.*, 14 [10] 337–41 (1935); erratum, *ibid.*, 14 [12] 395 (1935).

Electric furnace for firing porcelain. ESSER. *Elektrowärme*, 5 [9] 229–31 (1935).—The furnace, for biscuit firing, is a twin-tunnel furnace with two chambers, one over the other. The material moves in counterflow so that each hot end serves as preheating chamber for the adjacent cold end. The heating elements are of the profiled rim type and arranged at the bottom, on the ceiling, and between the two chambers, this row of elements thus heating both chambers. Because of their stiffness, only a few supporting and suspension points are necessary, permitting free radiation into the furnace. The material is placed in baskets and containers and carried through the furnace on glide rails of the same material as the heating elements; the temperature is 800°C. Particular care is taken for easy accessibility in case of replacing heating elements and for charging and discharging on both ends on platforms which can be automatically lifted from one to the other chamber level. The dimensions of the furnace are 2 x (16 x 1 x 0.3) m., and capacity is 4000 kg. in 24 hr., with a rating of 120 kw. The energy consumption is 450 kw.-hr. per ton at 800°C. M.H.

Electric kiln for potters. ANON. *Studio* [London], 107, 282 (1934).—A drying chamber is fitted as an integral part of the kiln. The heater elements are mounted in specially constructed frames manufactured from Dutch clay and cork; burning out of the cork results in the formation of valuable air pockets. In design attention has been paid to economy of space. G.H.A.

Fuel oil for kilns. T. F. UNWIN. *Ceram. Age*, 24 [2] 58–59 (1934).—The advantages of fuel oil in firing periodic kilns are pointed out. Numerous actual installations of oil-burning equipment for both drying and firing of clay products are described and discussed. F.G.H.

Fundamentals, rules, and examples of computing furnaces: III, Background and development of formulas used in computing heat developed by firing gases in the kiln. H. SCHWIEDESSEN. *Arch. Eisenhüttenwesen*, 9, 23–30 (1935).—Formulas are presented which, under certain assumptions, permit the computation of changes in the amount of fuel used in case the following factors vary: adjustment of the firing process, pre-heating, and calorific value. Examples are given for some computations. For Part II see *Ceram. Abs.*, 14 [8] 197 (1935). W.M.C.

Heat of combustion of isobutane. FREDERICK D. ROSSINI. *Jour. Research Nat. Bur. Stand.*, 15 [4] 357–61 (1935); R.P. 833. Price 5¢.—The data of the present investigation yield, for the heat evolved in the combustion of gaseous isobutane in oxygen to form gaseous carbon dioxide and liquid water, at 25°C and a constant pressure of 1 atmosphere, the value 2871.06 ± 0.53 international kilojoules per mole. R.A.H.

High-temperature electric resistance furnace. G. W. ASHTON. *Mech. World*, 98 [2541] 245–46 (1935).—With the recent introduction of Kanthal alloys claiming a melting point of 1660°C, a high resistance to sulfur gases, and a working temperature of 1350°C, a furnace was built fitted with elements of this material to give a working temperature up to 1300°C. Practical details of the furnace construction are given. Illustrated. E.J.V.

Kentucky coals, classification and analyses. P. B. PLACE. *Combustion*, 6 [7] 24–28 (1935).—P. discusses location, analyses, and characteristics of various coals of the U.S. He identifies the various seams and trade names of Kentucky coals, discusses their characteristics, and indicates their adaptability to stoker and pulverized coal firing. See also "Analyses—" *Ceram. Abs.*, 14 [10] 255 (1935); "Ohio—" *ibid.*, p. 256. H.E.S.

Kilns and kiln design. GARNETT HARTLEY. *Claycraft*, 8 [10] 431 (1935).—H. discusses the merits of the intermittent rectangular kiln and the continuous kiln. The intermittent kiln, if properly designed so as not to be affected by variable wind pressures and weather changes, can be operated efficiently for common and face brick and tile. The flues must be sufficiently large and properly

located to permit the complete disposition of the water-smoking gases and to control the firing procedure properly. It is recommended that the flash wall be built as a permanent fixture in the kiln rather than to attempt to build one at each setting. With this permanent construction a much higher percentage of good ware will be produced. In continuous kilns more facilities should be provided for adequately drying ware. M.C.S.

Methods of attacking heat-transmission problems. C. H. LANDER. *Trans. Inst. Chem. Engrs.* [London], **12**, 86–95 (1934).—Experiments were made to show that non-luminous gases at high temperatures and in thick layers are important radiators of heat. The importance of a knowledge of scientific principles in furnace design is emphasized. G.H.A.

Microchemical analysis of solid fuels. W. R. KIRNER. *Ind. Eng. Chem., Anal. Ed.*, **7** [5] 294–99 (1935).—The difficulties involved in the application of Pregl's micro-methods to the analysis of solid fuels are pointed out, and the advantages of present modifications are discussed. These modifications are necessitated by the unique physical and chemical characteristics of solid fuels which involve (1) their complex composition, (2) low percentage of several of the constituents present, (3) possibility of incomplete combustion of gaseous decomposition products, (4) formation of highly combustion-resistant cokes, (5) their limited solubility in all solvents, and (6) lack of a definite standard to which analytical results can be compared. Other modifications to existing methods are suggested, some of which are in process of investigation in the Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa. See also "Direct—" *Ceram. Abs.*, **14** [9] 228 (1935). F.G.H.

Regenerative or recuperative firing. HANS BAUMER. *Sprechsaal*, **68** [34] 526–27 (1935).—B. discusses recuperative firing and an installation combining the advantages of both recuperative and regenerative firing. Illustrated. M.V.C.

Regulating temperature in brick kilns. A. PELLACINI. *Corriere Ceram.*, **26** [9] 386–87 (1935).—The use of Seger cones is explained. M.V.C.

BULLETINS

Analyses of Coals and Other Solid Fuels, 1932–1934. J. H. H. NICOLLS AND C. B. MOHR. *Can. Dept. Mines, Mines Branch Pub.*, No. 753 (1935). 58 pp., 3 tables. Paper. Price 10¢. The authors present a compilation of analyses of Canadian solid fuels, of bituminous coals purchased by the Department of Pensions and National Health, and of miscellaneous imported fuels. G.M.H.

Analyses of Samples of Natural Gas from Ontario in 1932 and 1933. P. V. ROSEWARNE AND R. J. OFFORD. *Can. Dept. Mines, Mines Branch, Memorandum Series*, No. 63 (1934). 5 pp., mimeographed. Free. G.M.H.

Research in the Effect of Operating Temperatures on the Combustion of Industrial Gas. COMMITTEE ON INDUSTRIAL GAS RESEARCH. *Amer. Gas Assn. Testing Lab. Rept.*, No. 748, Dec., 1934.—Some results obtained during an investigation of the performance of ten furnaces operating at atmospheric pressure and involving many variables in construction and operation are summarized as follows: Fundamentals of combustion: (1) Combustion of an air-gas mixture containing at least the amount of air theoretically required for complete combustion was completed entirely at the surface of the well-defined inner cone; (2) the amounts of excess air required to repress the products of dissociation bore a definite relation to the flue-gas temperature. Burners: (1) The relationship between the amounts of excess oxygen required for complete combustion and the flue-gas temperatures was the same for all furnaces employing totally premixed air and gas; (2) furnaces equipped with nozzle mixing burners required more excess oxygen for complete combustion than did the same furnaces utilizing premixing burners. Combustion air temperature: The amount of gas which could be completely burned per cubic foot of combustion space increased as the combustion air temperature was raised. Combustion wall temperatures: The relation between flue-gas temperatures and excess oxygen remains constant for similar furnaces operating at equal unit input rates regardless of combustion chamber wall temperatures. Fuel gases: (1) It was possible to burn amounts of both manufactured and natural gas per cubic foot of combustion space considerably in excess of those now used in industrial heating processes; (2) when totally premixed air and gas were employed the type of fuel gas exerted no influence on the relation between amounts of excess oxygen required for complete combustion. At equal flue-gas temperatures, nozzle mixing burners required greater amounts of excess oxygen to provide complete combustion for coke-oven than for natural gas. J.M.K.

PATENTS

Brick and tile kiln. ALOIS HABLA. U. S. 2,016,996, Oct. 8, 1935 (Sept. 25, 1934). U. S. 2,020,641, Nov 12, 1935 (Sept. 21, 1934).

Continuous tunnel kiln. P. D'H. DRESSLER (Swindell Dressler Corp.). U. S. 2,020,140, Nov. 5, 1935 (March 28, 1934). In a continuous tunnel kiln the combination with the kiln chamber of kiln cars for moving goods through the chamber, the cars having goods-supporting platforms and spaces beneath the platforms, combustion heating means for heating the goods without contact of the latter with the heating gases, combustion chambers at the opposite sides of the kiln chamber, and bodies of highly heat-conducting material associated with the chambers and receiving heat directly therefrom and radiating heat into the spaces.

Tunnel kilns. B. J. MOORE. Brit. 435,452, Oct. 2, 1935 (Feb. 22, 1934).

Walking beam furnace. R. S. COCHRAN AND J. R. MOSER (Surface Combustion Corp.). U. S. 2,017,024, Oct. 8, 1935 (Aug. 31, 1934).

Geology

Authigenic feldspars in sediments. ALLEN C. TESTER AND GORDON L. ATWATER. *Jour. Sed. Petrology*, **4** [1] 23–31 (1934).—Authigenic feldspars occur in many types of rocks from Cambrian to Cretaceous in age. In certain cases the growth probably occurred after consolidation and during a period of replacement by meteoric waters. Feld-

spars are common in limestone and dolomite, and in some arenaceous beds the feldspar is known to constitute about 30% of the fine grades. G.M.H.

Bleaching earth prospects in Tennessee. G. I. WHITLATCH. *Ceram. Age*, **24** [2] 37–40 (1934).—The bleaching effect of seventeen Tennessee clays upon crude vegetable and mineral oils is described and discussed. F.G.H.

Buff- and white-firing clays of southern Saskatchewan. F. H. MCLEARN AND J. F. MCMAHON. *Geol. Surv. Canada Summary Rept. 1933* [Part *B*], *Pub.*, No. 2353, pp. 32–157 (1934).—These clays occur at two levels, in the Whitemud formation of the Cretaceous and in the Willowbunch member of the early Tertiary. Both series of clays are derived from the weathering in place of feldspathic material derived from a land mass west of the present Rocky Mountains. Several occurrences of these clays are described and ninety tables of tests on the clays are given. The clays are briefly reviewed in order of the classes into which they fall, *viz.*, ball clays, clays for the manufacture of refractories, clays for general pottery purposes, and clays suitable for use in the manufacture of vitrified products. A note by F. J. Fraser on the petrography of the samples is appended. G.M.H.

Ceramic clays. MINER L. HARTMANN. *Chem. Met. Eng.*, **42** [8] 419 (1935).—A survey of the ceramic industries and resources of Calif. for 1933 is presented. M.C.S.

Ceramic industries of west and middle Tennessee: I–II. G. I. WHITLATCH. *Ceram. Age*, **23** [1] 5–8; [2] 39–42 (1934).—Ball, wad, and sagger clays are the principal mining products. Common brick, face brick, and building tile are the chief clay products. A comprehensive digest is given of the clay producers and of the ceramic plants operating in the territory. Pertinent facts covering future possibilities for different branches of ceramic manufacture are also given. Illustrated. F.G.H.

Ceramic raw materials. B. M. BURCHFIEL. *Chem. Met. Eng.*, **42** [8] 435 (1935).—Clays found in Calif. range from low-grade surface clays to ball clays and china clays. There are also excellent plastic, semiflint, and flint fire clays. Other ceramic materials found in Calif. include feldspar, flint, talc, borax, and barium carbonate. M.C.S.

Ceramics in the Tennessee Valley area. A. F. GREAVES-WALKER. *Ceram. Age*, **23** [4] 109 (1934).—Prospective developments are described in the exploitation of ceramic raw materials within the area developed by the Tennessee Valley Authority. F.G.H.

Choice of clay in the ceramic industry. F. CHALAMEL. *Céramique*, **38** [562] 1–7 (1935).—For determining the correct clay to use in a particular case the physical and chemical nature, firing and molding behavior, and effect on other clays must be known. M.H.B.

Clay content of the soil as related to climatic factors, particularly temperature. H. JENNY. *Soil Sci.*, **40** [2] 111–28 (1935).—The clay contents of 151 soil profiles developed on crystalline rocks in the eastern U. S. were correlated with climatic factors. It was obvious that within each of seven groups of parent materials the average clay content of the soil increases from north to south. Temperature is considered to be the major factor that is responsible for the high clay levels in the south. For constant moisture values the clay-temperature function is of exponential nature and resembles Van't Hoff's temperature rule. An idealized clay-climate surface was constructed which shows the variation of "climatic clay" in soils derived from granites and gneisses as a function of moisture and temperature. G.R.S.

Clay varves in geological time-recording. W. J. MCCALLIEN. *Sci. Prog.*, **30**, 67–71 (July, 1935).—The method of the Swedish geologist, Gerard de Geer, for estimating the age of sediments to the exact year by the clay varve has been applied to dating the Ice Age in Britain. (Varve is Swedish for a turn or revolution such as the complete round of the hands of a clock.) H.H.S.

Clays and sand of Wealden of Hainaut and notes on kaolins and ordinary and refractory clays of Belgian subsoil. R. MARLIÈRE. *Pub. Assn. Ingén. École Mines de Mons*, No. 48, 57 pp. (1934); abstracted in *Referat. Silikatliteratur*, No. 785 (1934).—The deposits, composition, and properties of Belgian clays and kaolins are described in detail. M.V.C.

Clays of Saskatchewan. W. G. WORCESTER. *Clay Prod. News*, **8** [8] 3 (1935).—The clay deposits of Saskatchewan represent practically every class of clay used in present-day manufacturing, including whiteware, yellow ware, low-grade refractory, intermediate, and high-quality refractory clays. In addition there are the special-purpose colloidal clays such as those required for decolorizing and refining oils and soaps. See also "Saskatchewan—" *Ceram. Abs.*, **14** [7] 171 (1935). M.C.S.

Cobalt. G. H. MCINTYRE. *Enamelist*, **12** [12] 30–33 (1935).—Cobalt oxide is used in the porcelain enameling industry usually in the form of an intermediate black oxide, cobalto-cobaltic oxide, Co_3O_4. The workable deposits of cobalt ores are listed and the composition of the product of each is discussed. The metallurgy of cobalt is briefly outlined and the various ceramic uses of cobalt are mentioned. E.J.V.

Color distribution in fluorite in relation to the crystal structure. H. HABERLANDT AND A. SCHIENER. *Z. Krist.*, **90**, 193–213 (1935).—The color distribution in fluorite is affected by impurities (active impurities, sulfide inclusions, and rare earths) which are included in the fluorite in a regular way during the crystal growth. H.I.

Crystal structure of swedenborgite, $NaBe_4SbO_7$. L. PAULING, H. P. KLUG, AND A. N. WINCHELL. *Amer. Mineralogist*, **20** [7] 492–501 (1935).—The hexagonal mineral, swedenborgite, was first described in 1924 as a sodium aluminum antimonate with the following properties: colorless to light yellow, hardness about 8, axial ratio $c/a = 1.6309$, definite basal cleavage. Later it was reported as being of the composition $NaBe_4SbO_7$. The X-ray investigation and crystal structure analysis conducted by the authors at the Calif. Institute of Technology checks the latter composition and establishes the unit structure as consisting of two molecules of the composition $NaBe_4SbO_7$. F.J.Z.

Crystallographic relationships between silicates and phosphates. Contribution to the knowledge of beryllonite. B. GOSSNER AND J. BESSLEIN. *Centr. Mineral. Geol., Abt. A*, No. 5, pp. 144–51 (1934); abstracted in *Referat. Silikatliteratur*, No. 547 (1934). M.V.C.

Dating of Late-Glacial clay varves in Scotland. GERARD

DE GEER. *Proc. Roy. Soc. Edinburgh*, **55**, 23 (1935); see "Clay varves—", p. 37. H.H.S.

Determination of talc in talc raw materials. O. KALLAUNER AND I. ALEJNIKOV. *Sprechsaal*, **68** [8] 113–14 (1935).—The finely powdered samples are calcined at 750°C and treated at first in a water bath with hydrochloric acid and then with soda solution. In this way magnesite, limestone, dolomite, brucite, goethite, limonite, siderite, nontronite, azurite, malachite, kaolinite, olivine, etc., present in talc rock are eliminated. Talc remains in the undecomposed residue. Details of procedure are given. M.V.C.

Diatom as a filtration medium. ANON. *Enamelist*, **13** [1] 18 (1935).—An air filter employing a diatomaceous filter candle has been developed for removing oil and water from compressed air used for spraying. Illustrated. E.J.V.

Earthenware clays. H. LEHMANN AND K. ENDELL. *Ber. deut. keram. Ges.*, **16** [6] 306–14 (1935).—Results of an investigation of six typical German earthenware clays are given. According to the ceramic, colloid-chemical, and X-ray properties, these clays are intermediate between washed kaolin and highly refractory plastic clays. These clays have a quartz content of 1 to 20% less than 2 microns in size. This fine quartz gives the clays a lighter color. The X-ray investigations on kaolins and clays show an inner interference which indicates mica or an unknown clay mineral. As the sum of exchangeable bases in earthenware clays increases Pfefferkorn's plasticity value also increases. E.J.V.

Electrolyte content of two clays. F. K. SCHLÜNZ. *Chem. Erde*, **8**, 504–506 (1933).—The electrolyte content of two clays as determined on the sample air-dried at 105°C after preparation with $N/100$ ammonia, diluting with distilled H_2O, and filtering with a collodion filter was found to be 0.21% for a septarian clay from Papendorf and 0.84% for a diluvial clay from Malliss. Quantitative analyses of the filtrates gave large quantities of Ca and SO_4 for the Papendorf clay and large quantities of alkalis and chlorides for the Malliss clay. The Malliss clay also contained a significantly larger amount of particles less than 1 micron in diameter than the Papendorf clay. H.I.

Experimental investigation of magnesium iron-bearing monticellites. D. S. BELYANKIN, K. M. FEODOT'EV, AND C. S. NIKOGOSYAN. *Neues Jahrb. Mineral. Geol.*, **68A**, 337–47 (1934).—Optical properties of five synthetic monticellites in the series $Ca_2SiO_4 \cdot Mg_2SiO_4$–$Ca_2SiO_4 \cdot Fe_2SiO_4$ indicate that they form a perfect isomorphous series. H.I.

Feldspar obtained from German rock by flotation. H. ZIERGIEBEL. *Emailwaren-Ind.*, **12** [18] 149 (1935).—Quartz micas and ores can be easily separated from feldspars, while the separation of silicate constituents is difficult. Feldspars showing signs of weathering are unsuitable. M.V.C.

Feldspars of the Pyrenees. V. CHARRIN. *Céram., Verrerie, Email.*, **2** [8] 345–46 (1934).—Six feldspars from various zones of the French Pyrenees are analyzed. M.V.C.

Geologic distribution of fire clays in the United States. J. R. CHELIKOWSKY. *Jour. Amer. Ceram. Soc.*, **18** [12] 367–90 (1935).

Grunerite from Rockport, Massachusetts, and a series of synthetic fluor-amphiboles. N. L. BOWEN AND J. F. SCHAIRER. *Amer. Mineralogist*, **20** [8] 543–51 (1935).—The chemical composition and optical properties of grunerite that occurs in Rockport fayalite are presented. The optical properties of the grunerite, $(OH)_2(Fe,Mn)_7(Si_4O_{11})_2$, and cummingtonite, $(OH)_2Mg_7(Si_4O_{11})_2$, series are listed, and a method of producing synthetic fluor-amphiboles, together with their optical properties, is given. F.J.Z.

Hydrocalumite ($4CaO \cdot Al_2O_3 \cdot 12H_2O$), a new mineral from Scawt Hill, Co. Antrim. C. E. TILLEY. *Mineral. Mag.*, **23**, 607–15 (1934).—Chemical, X-ray, and optical data are given. The mineral is monoclinic with perfect (001) cleavage. Refractive indices: $\alpha = 1.535$, $\beta = 1.553$, $\gamma = 1.557$. Bx_a nearly (001). $2V = 24°$. On heating, the mineral becomes uniaxial at 90 to 95°C. On cooling, the original value of the optic angle is slowly regained. The structure determination shows complete hexagonal symmetry. The actual monoclinic symmetry is probably achieved by small displacements of the atoms from their ideal positions. H.I.

Hydrous silica deposit north of Minaki, Ontario. J. F. WRIGHT AND C. H. STOCKWELL. *Geol. Surv. Canada Summary Rept. 1933* [Part *D*], *Pub.*, No. 2351, pp. 1–6 (1934).—A deposit of white, hydrous, noncrystalline silica occurring in Pre-Cambrian pegmatite, sillimanite gneiss, and lava which have been leached by hot waters is described. Several possible uses for the material are suggested, *e.g.*, as a filtrant, as ganister, etc. The extent of the deposit is not known. G.M.H.

Important constituent of fuller's earth. J. DE LAPPARENT. *Compt. rend.*, **201** [10] 481–83 (1935).—Two groups of fuller's earth are distinguished generally, *viz.*, kaolinite-halloysite and montmorillonite. A very exact spectrographic and X-ray examination revealed the existence of another constituent which was given the name "attapulgite" and has the composition $(OH)_2 \cdot H_2(Mg_2,Al_{4/3}) \cdot H_4Si_8O_{20}$. M.H.

Italian kaolins. FAUSTO POZZI. *Centro Studi Ceram.*, **1** [2–3] 36 (1934).—The properties of Italian kaolins are given briefly. M.V.C.

Kaolin of Sardinia. FELICE DE CARI. *Centro Studi Ceram.*, **2** [5] 60 (1935).—The paper on Sardinian kaolin given at the National Congress of Chemistry held in Sardinia (April–May) is briefly outlined. M.V.C.

Lithic rock. V. C. *Verre & Silicates Ind.*, **6** [15] 281–82 (1935).—The composition and properties of lepidolite and amblygonite, the principal lithic minerals, are described. The effect of lithium in glass and enamels is briefly given. M.V.C.

Lithium salts and lithium ores. G. H. CHAMBERS AND E. G. ENCK. *Chem. Industries*, **34** [5] 405–408 (1934).—Lithium, compared to most of the rarer elements, has had a long and commercially important career. There are four commercially important lithia minerals, and all of them occur in pegmatite dikes: amblygonite, spodumene, lepidolite, triphylite-lithiophilite. The U.S. is the most important producer of lithium minerals, and some ore is exported to Europe. Lithium carbonate was the first compound of lithium to be made. Analyses of this and other lithium salts are given. The importance of lithium in the glass and ceramic industry is discussed. M.J.H.

Magnesite deposits, their formation, geological description, and investigation. K. REDLICH. *Z. Prakt. Geol.*, No. 11, pp. 166–75 (1934); abstracted in *Referat. Silikatliteratur*, No. 1273 (1935). See also "Magnesite—" *Ceram. Abs.*, **14** [10] 258 (1935). M.V.C.

Magnesite deposits of Russia, Manchukuo, Japan, Sweden, and Norway. L. LOCH AND K. A. REDLICH. *Z. Prakt. Geol.*, **43** [1] 1–10 (1935); abstracted in *Referat. Silikatliteratur*, No. 1426 (1935).—A brief review is given of the chief deposits and composition of magnesite. M.V.C.

Magnesite of Salinelles (France). V. CHARRIN. *Verre & Silicates Ind.*, **6** [17] 321–23 (1935). M.V.C.

Measurement of imbibitional water. E. W. RUSSELL AND R. S. GUPTA. *Jour. Agri. Sci.*, **24** [2] 315–25 (1934).—The method of Fisher for determining the weight of water imbibed by a soil is criticized. In this investigation the weight of water and of different hydrocarbons held by the soil under two different external conditions was measured using (1) the moisture equivalent centrifuge against a field of 1000 g., and (2) the Keen-Raczkowski box. The volume of water imbibed by the soils was also estimated from the swelling of the soil in the Keen-Raczkowski box. Four soils were investigated, two from Rothamsted, one from the Sudan, and a Gloucester soil. The hydrocarbons used were paraffin, tetralin, decalin, and xylene. The determinations of the weight, volume, and density of the imbibed water by the different methods gave concordant results for three out of four soils. The discrepant results for the fourth soil are attributed to the large quantities of readily decomposable organic matter which it contained. It is concluded that Fisher's assumption, that the volume of the hydrocarbon held in the soil pores in the centrifugal field equals the volume of water so held, is only partially true. Nevertheless it is agreed that the weight or volume of water imbibed by a soil can be measured. The accuracy of the different methods, however, is not great enough to allow a consideration of the small differences usually found between one method and another. G.H.A.

Mendozite and tamarugite in Missouri. W. D. KELLER. *Amer. Mineralogist*, **20** [7] 537–39 (1935).—The origin, occurrence, and optical properties of mendozite, $Na_2O \cdot Al_2O_3 \cdot 4SO_3 \cdot 22H_2O$, and its alteration product, tamarugite, $Na_2O \cdot Al_2O_3 \cdot 4SO_3 \cdot 12H_2O$, are discussed. F.J.Z.

Method for removing iron oxide coatings from minerals. M. DROSDOFF AND E. TRUOG. *Amer. Mineralogist*, **20** [9] 669–73 (1935).—Iron oxide coatings on minerals interfere with petrographic and X-ray studies of minerals. This coating can be removed if a water suspension of the mineral is first treated with hydrogen sulfide, and the resulting sulfides of iron are dissolved in 0.05 *N* hydrochloric acid. Other minerals such as silicates and apatite are not appreciably affected, although carbonates would be. F.J.Z.

Mineralogically important constituents of clays, in particular of fuller's earths. H. LONGCHAMBON. *Compt. rend.*, **201** [10] 483–86 (1935).—The properties of constituents of clay, such as montmorillonite, confolensite, steargilite, and palygorskites, are discussed and their geological deposits are reviewed. M.H.

Montmorillonite in the class of the phyllitous silicates. J. DE LAPPARENT. *Compt. rend.*, **201** [13] 527–29 (1935).—Recent close examination disclosed that the ratio of H_2O and Si to Al is greater than previously assumed and that the correct formula for the mineral is $(OH)_8 \cdot Al_8Si_4O_{16} + (OH)_4MgSi$. M.H.

Narsarsukite in Montana. WILLIAM A. P. GRAHAM. *Amer. Mineralogist*, **20** [8] 598–601 (1935).—The optical and chemical characteristics of the Mont. mineral check the values given for the Greenland mineral, narsarsukite. F.J.Z.

Obonga-Kashishibog area, Thunder Bay district, Ontario. D. F. KIDD. *Geol. Surv. Canada Summary Rept. 1933* [Part *D*], *Pub.*, No. 2351, pp. 16–37 (1934).—The geology of the area and six chromite occurrences are described. G.M.H.

Origin of tektites. FLETCHER WATSON, JR. *Nature*, **136** [3429] 105–106 (1935).—W. reviews the theories advanced for the origin of tektites (small glassy masses of lens, pear, or dumb-bell shape which are found in many places) and concludes that no satisfactory meteoric theory of their origin has been advanced. J.L.G.

Pectolite. M. A. PEACOCK. *Z. Krist.*, **90**, 97–111 (1935).—A morphological and optical study of needles of pectolite ($H_2O \cdot Na_2O \cdot 4CaO \cdot 6SiO_2$) from Paterson and Union Hill, N. J., proved that the mineral is not monoclinic but triclinic. It belongs in the wollastonite group with vogtite, schizolite, and rosenbuschite and is isomorphous with them. H.I.

Permeability of unconsolidated rocks. FREDERICK G. TICKELL. *Bull. Amer. Assn. Petroleum Geol.*, **19** [8] 1233–38 (1935).—Porosity is an exponential function of compaction pressure. An instrument has been designed which can be used for measuring the permeability of cemented and uncemented sediments of both low and high permeabilities. The instrument was used to study the effect of grain-size distribution and compaction on the permeability of unconsolidated sediments. The results show that the addition of sand to a fine-grained aggregate has less effect on the permeability when a mixture is highly compressed than when compressed to a lesser degree, *i.e.*, increasing sandiness of a deeply buried stratum has less effect on the permeability than in the case of a shallow stratum. G.M.H.

Pseudobrookite. CHARLES PALACHE. *Amer. Mineralogist*, **20** [9] 660–63 (1935).—New forms of the mineral pseudobrookite, Fe_2TiO_5, are described. F.J.Z.

Pyrophyllite in San Diego County, California. L. M. RICHARD. *Bull. Amer. Ceram. Soc.*, **14** [10] 353 (1935).

Pyroxene group. A. N. WINCHELL. *Amer. Mineralogist* **20** [8] 562–68 (1935).—W. discusses the inadequacy of the present system of naming minerals that occur in such variation systems as the diopside-clinoenstatite and diopside-hedenbergite series. Diagrams showing the variations in composition and optical properties of various pyroxene series are included. F.J.Z.

Qualitative characteristics and technological evaluation of deposits of refractory clays and kaolins. E. K. KELER. *Ogneuporui*, **3** [5] 376–79 (1935).—K. describes a typical scheme of the investigation of deposits that has been worked out by the State Ceramic Research Institute. It comprises eight stages of the following approximate duration: (1) investigation of samples of the preliminary exploration, 2 months; (2) systematic exploration of the

deposit, 1 year; (3) qualitative characteristics of the clays, ends in 6 months after the end of the foregoing stage; (4) calculation of the supply of clays of different grades, 2 months; (5) preliminary technological essays, 4 months; (6) drafting out the plan of the industrial utilization of the deposit; (7) laboratory investigation and plant verification of the production processes, 15 months; (8) projecting work, 6 months; total: 4 years, 7 months (less for small deposits). P.B. & E.S.

Regulating the plastic properties of clay. A. V. Terbshchenko and I. E. Dudavskii. *Ogneuporui*, **3** [2] 127–34; [3] 208–16; [4] 298–304 (1935).—The dependence of the plasticity of clays on the composition of cations of the sorbed complex in the absence of electrolytes in the liquid phase, which was proved theoretically before, has been confirmed experimentally. This dependence makes it possible to obtain changes in the properties of raw materials that thoroughly alter their technological character by changing the composition of cations of the sorbed complex. Saturation with sodium increases the plastic properties of clay. Saturation with aluminium produced an immense water content with, simultaneously, an insignificant plasticity. The general trend of changes of properties corresponded to theory: ions of a lower valency led to a higher plasticity. The positive influence of Na-ions on the properties of clay is to some extent neutralized by the loosening of Na-ions because of the dissociation of particles saturated with sodium. P.B. & E.S.

Researches on Westerwälder clays. K. Zimmerman. *Sprechsaal*, **68** [10] 145–46; [11] 161–64 (1935).—Casting properties of the slip, use of the clays for whiteware, hair cracks in the body, etc., were investigated. Details are given. M.V.C.

Saxony clays in the glass industry. K. Litzow. *Sprechsaal*, **68** [29] 458 (1935).—The use of Saxony clays, whose composition is analyzed, for the production of pots for melting glass is discussed in detail. M.V.C.

Spectrographic analysis of tourmalines with correlation of color and composition. T. W. Warner, Jr. *Amer. Mineralogist*, **20** [7] 531–36 (1935).—Selected samples of tourmaline, ranging from very dark green to red, were analyzed spectrographically. General conclusions regarding the effect of various elements present and their ratios on colors are presented. F.J.Z.

Spruce Pine district, North Carolina. Anon. *Ceram. Age*, **23** [4] 101 (1934).—The mining, grinding, and processing of clay, feldspar, kyanite, and pyrophyllite in the Spruce Pine district of North Carolina are briefly described. F.G.H.

Staining minerals for easier identification in quantitative mineragraphic problems. A. M. Gaudin. *Econ. Geol.*, **30** [5] 552–62 (1935).—G. reviews and classifies various methods of changing the appearance of minerals to aid in their microscopic identification and gives examples of stains used in solving practical mineragraphic analysis problems. J.L.G.

Structural relationship of nontronites and montmorillonite. J. W. Gruner. *Amer. Mineralogist*, **20** [7] 475–83 (1935).—Nontronites have been classed as iron kaolinites by some investigators and grouped with zeolites by others. The X-ray investigation conducted by G. at the Univ. of Minn. shows conclusively that nontronites, including morencite, pinguite, faratsihite, stilpnochloran, and chloropal are like montmorillonite in structure, having layer structures similar to vermiculites but unlike kaolinite and having no resemblance to the structures of zeolites. Chemical analyses and X-ray data obtained on several samples are tabulated, and descriptions of the unit cells are included. F.J.Z.

Structure of dickite and other clay minerals. C. J. Ksanda and Tom F. W. Barth. *Amer. Mineralogist*, **20** [9] 631–37 (1935).—New X-ray data obtained on a single crystal of dickite led to the following conclusions: (1) the shape and dimensions of the unit cell of dickite have been correctly determined by Gruner; (2) dickite is composed of discrete sheets of cations and anions parallel to the "*a*-*b*" plane stacked on top of each other in the manner described by Gruner; (3) the two-dimensional arrangement of the several atoms within each sheet is, however, different from any of the arrangements considered by Gruner; (4) since the crystal structures of kaolinite, nacrite, vermiculite, and halloysite have been calculated on the basis of the incorrect structure of dickite, the proposed structures of all these minerals can not be accepted as being correct without further proof. F.J.Z.

Survey of the Westerwäld clay and quartzite mining area. A. Hasebrink. *Ber. deut. keram. Ges.*, **16** [7] 355–72 (1935).—A description of the mining methods, deposits, etc., is given, with special reference to the geological conditions. E.J.V.

Symmetry of the rhombic pyroxenes. T. Ito. *Z. Krist.*, **90**, 151–62 (1935).—It is suggested that the so-called rhombic pyroxenes are pseudorhombic and are the twinned forms of monoclinic pyroxenes. H.I.

Talc, an inert chemical of many varied uses. A. E. Karr. *Chem. Industries*, **34** [1] 31–32 (1934).—The history, development, and uses of talc are given. M.J.H.

Technical basis of bleaching-clay industry. P. G. Nutting. *Bull. Amer. Assn. Petroleum Geol.*, **19** [7] 1043–52 (1935).—Clay particles are potential oil-bleaching agents when their surfaces hold H and OH radicals adsorbed in a thin layer. When these are driven off by heat, open bonds are left which select from oil the darker, more basic constituents. Certain clays are inactive because bases such as iron, aluminum, and calcium already occupy the surface bonds, and may be activated by replacement of these bases by the H of an acid. The bleaching clays of commercial interest are the active clays of the Southeast and the activable bentonites of the Southwest and Southeast. No first-class clays of either type have been found in the mid-continent region. All the best active clays are substantially equal in bleaching power. The same is true of the activable clays. These clays occur in large quantities. Glauconite and Ordovician bentonite may be of some special service locally but can not compete with the commercial clays for bleaching purposes. Special treatments of clays, enhancing their bleaching power, have been found to be not worth the added cost. Methods of testing and rating bleaching clays, are briefly outlined. See also "Bleaching—" *Ceram. Abs.*, **13** [2] 47 (1934). G.M.H.

Thetford and Disraeli Quadrangles, Quebec. H. C. Cooke. *Geol. Surv. Canada Summary Rept. 1933* [Part *D*], *Pub.* No. 2351, pp. 121–38 (1934). The geology of

the area and interesting chromite deposits therein are described. G.M.H.

Tidal plants in the formation of clay rhizoconcretions. JACQUES ROUSSEAU. *Jour. Sed. Petrology*, **4** [2] 60–64 (1934).—The concretions studied are actually in the making on the tidal shore of a portion of the Saint Lawrence River. The nuclei around which they form are roots of *Scirpus rufus* and *Juncus balticus var. littoralis*. The roots grow vertically in a gray-blue clay. Root decay causes clay oxidation, the results of which are ocherous cylinders more compact than the original and surrounding clay. The periodic impact of tidal waves releases the concretions from the matrix and the spring tides carry them to the upper part of the shore. G.M.H.

BOOKS AND BULLETINS

Annual Report of the Minister of Mines of British Columbia for the Year Ended December 31, 1934. Price 50¢. Listed in *Can. Mining Jour.*, **56** [9] 443 (1935). G.M.H.

Bentonite. ANON. *Silica Products Co. Bull.*, No. 107; reviewed in *Foundry*, **62** [10] 112 (1934). Information on the properties, sources, geology, production, and uses of bentonite is presented. F.G.H.

Clay Winning and Its Costs in the Provinces of Ontario and Quebec. J. F. MCMAHON. *Can. Dept. Mines, Mines Branch, Pub.*, No. 754 (1935). 90 pp., 4 tables, 22 figs. Price 25¢. This excellent report presents a general consideration of clay gathering and describes forty-three clay-gathering operations with analyses of cost data. In the workings studied, digging and blasting costs varied from 80 to 90% of the total winning cost. Labor charges for drilling and blasting varied from 22 to 72% of the total cost, averaging 44%. Labor charges for digging and loading varied from 26 to 98% of the digging and loading costs, averaging 64%. Labor charges in transportation represented from 29 to 89% of the transportation costs. In steam-shovel operations labor charges approximated 5 cents per ton, fuel and lubricants approximating 2 cents. In the case of drum and cable haulages, costs approximated 5 cents per ton over distances of from 50 to 200 yards. Horse and wagon haulage approximated 14 cents per ton for 300 yards and 10 cents for 100 yards. Horse-drawn track cars cut down haulage costs considerably. In locomotive haulage there is no relationship between distance and cost per ton. Blasting costs varied from 3.8 to 9.4 cents per ton of shale and 1 cent per ton of clay. Overburden removal costs varied from 2 to 25 cents per ton of desired material and are in direct proportion to the depth removed, approximating 1.2 cents per foot per ton of desired material and from 2 to 30% of the total winning costs. The report contains an excellent bibliography on clay winning and its costs, 1922–1932. G.M.H.

Geology of Southern Saskatchewan. F. J. FRASER, F. H. MCLEARN, L. S. RUSSELL, P. S. WARREN, AND R. T. D. WICKENDEN. *Geol. Surv. Canada Memoir* No. 176, *Pub.* No. 2373 (1935). 8 chapters, appendix, 5 plates, 4 figs. Paper. Price 50¢. Accompanying this memoir are map 267*A*, *Pub.* No. 2271, Regina sheet, showing the geology of the area; and *Pub.* No. 2341, sections supplementing the Regina sheet, both being in a carton for filing on the shelves. The geology of the southern part of the province is thoroughly discussed, with particular attention to the Whitemud and Willowbunch formations which are of particular importance to the clayworker. There are chapters on structure and on economic geology. No data are given on the properties of the clays as these have been dealt with in former reports. The Whitemud sediments were derived in Cretaceous time from a land mass to the west and were weathered more or less in place during or shortly after deposition. Fraser contributes a review of the petrography of over 1000 samples. A list of fossils is appended. This is a splendid reference work for anyone interested in the geology of clays. G. M. HUTT

Introduction to Geology. E. B. BRANSON AND W. A. TARR. McGraw-Hill Book Co., Inc., New York, 1935. 470 pp., 456 figs. Cloth. Price $3.75. Reviewed in *Bull. Amer. Assn. Petroleum Geol.*, **19** [8] 1240–41 (1935). G.M.H.

Laboratory Manual for General Geology. M. H. SECRIST. Macmillan Co., New York, 1935. 284 pp. Price $1.75. Briefly reviewed in *Econ. Geol.*, **30** [5] 580 (1935).—This book is a guide to laboratory work for beginning students in general geology. J.L.G.

Mineral Industries of Canada, 1933. Abridged ed. A. H. A. ROBINSON. *Can. Dept. Mines, Mines Branch, Pub.* No. 749, 39 pp. (1934). Price 10¢. R. presents brief notes on 59 Canadian minerals. G.M.H.

Mineral trade notes. ANON. *Bur. Mines Periodical Repts.*, **1** [3] 36 pp. (1935).—A review of current data on metals and industrial minerals (nonmetallics). R.A.H.

Minerals Yearbook, 1935. U.S. BUREAU OF MINES. Supt. of Documents, Government Printing Office, Washington, D. C. 1200 pp. Price $2.00. The 1935 volume continues the advances made in its immediate predecessor and incorporates many improvements based on constructive suggestions volunteered by close observers and students of the mineral industry. In addition to accurate official data on all commercially important minerals, there is a résumé of the principal economic developments in mining, as well as chapters dealing with progress in coal utilization, uses of petroleum fuels, petroleum and natural gas production, mine safety, and mineral developments from a world viewpoint. A new chapter on miscellaneous commercial gases and another on minor nonmetallic minerals appear for the first time. R. A. HEINDL

Petrographic Methods for Soil Laboratories. W. H. FRY. *U.S. Dept. Agric. Tech. Bull.*, No. 344, 96 pp. (Jan., 1933). Supt. of Documents, Washington, D. C. Price 10¢. Reviewed in *Jour. Sed. Petrology*, **4** [2] 96 (1934). G.M.H.

Petrography. F. Y. LEVINSON-LESSING. 4th enlarged and revised ed. Chief Editorial Office of Geologico-Prospecting and Geodetic Literature, Leningrad, 1935. 496 pp. Price 7R 50k. The general part is devoted to classification of rocks, their occurrence, weathering and metamorphism, mineralogical and chemical composition, structure, and mechanism of magma crystallization. The second part deals with the characteristic and systematic description of effusive, sedimentary, and metamorphic rocks. The book is well illustrated and gives a useful modern treatment of the subject. It will be of interest for students and specialists working in the field of petrography. A subject index is appended. S. I. PEREKAL

Victoria (Australia) Gold and Minerals. GEORGE BROWN. Mines Dept., Melbourne, 1935. 100 pp., maps. Clays, feldspars, diatomaceous earths, etc., are included. H. H. STEPHENSON

PATENTS

Apparatus for geological surveying. T. L. BAILEY AND W. S. WIEBUSCH (Shell Development Co.). U. S. 2,017,522, Oct. 15, 1935 (Oct. 30, 1933).

Core taking device. CONRAD SCHLUMBERGER (Schlumberger Well Surveying Corp.). U. S. 2,020,856, Nov. 12, 1935 (Feb. 7, 1934).

Chemistry and Physics

Accuracy of microscopical methods for determining refractive index by immersion. CHARLES PROFFER SAYLOR. *Jour. Research Nat. Bur. Stand.*, **15** [3] 277–94 (1935); R.P. 829. Price 5¢.—The accuracy of the immersion methods used in petrography for determining refractive indices is limited by the sensitivity of the criterion of match. In a series of tests, the sensitivity of three methods of ascertaining match was investigated as a function of objective aperture and size and shape of particle. The ordinary method of oblique illumination should never be employed unless, as in preliminary trials, inexact results will suffice. All the methods are capable of greater accuracy and higher sensitivity when employed with objectives of low numerical aperture. The double-diaphragm method has, in general, certain small advantages of accuracy and sensitivity over the Becke-line method. With the former, the plane of vibration of the light vector should always be parallel to the horizontal crosshair. With the latter, it should always be parallel to the vertical crosshair when those Becke-line effects are considered which occur along the right and left sides of the particle. R.A.H.

Analytical determinations with adsorption indicators. F. H. C. KELLY. *Jour. Australian Chem. Inst.*, **2**, 250–54 (Sept., 1935).—The new class of indicators, introduced by Fajans in 1923, improves the end-points in titrations in which a precipitate is produced. The color change is brought about on the surface of the precipitate rather than in the solution. Borates, Ba, Zn, and other difficult volumetric estimations are facilitated. H.H.S.

Analyzing enamel raw materials. L. STUCKERT. *Emailwaren-Ind.*, **12** [19] 153–57 (1935).—A rapid and exact determination of silica, based on the precipitation of silica converted into a soluble form by perchloric acid, is described. The oxyquinoline method for determining aluminum and iron oxides, its usability, and possible errors are described. The method of procedure is given. M.V.C.

Applications of an old method for the removal of iron. EUGENE WAINER. *Jour. Chem. Ed.*, **11** [9] 526–27 (1934).—A method is given for the quantitative separation of beryllium, aluminum, scandium, indium, the rare earths, titanium, zirconium, thorium, chromium, and bismuth from iron. M.J.H.

Band spectrum of beryllium monoxide. A. HARVEY AND H. BELL. *Proc. Phys. Soc.* [London], **47** [Part 3], No. 260, 415–19 (1935).—An equation is given for certain band-heads previously unaccounted for in the ultra-violet spectrum of BeO. L.E.T.

Borax bead technic. EUGENE W. BLANK. *Jour. Chem. Ed.*, **11** [10] 581 (1934).—The use of a porcelain crucible rather than the end of a platinum wire for exact borax bead work is recommended, and the procedure is given. Very slight color changes are readily seen, and two or more metals may be recognized by their characteristic borax bead colors. M.J.H.

Carbon determination in soils by the wet combustion method. W. S. MARTIN AND G. GRIFFITH. *Jour. Soc. Chem. Ind.*, **54** [28] 234–35 (1935).—The wet combustion method was selected as most suitable to the requirements of a routine laboratory with untrained assistants. The method described by Hardy was modified in (1) the method of introduction of chromic acid, (2) time of determination, and (3) in reducing to a minimum the rubber in contact with gas. By a preliminary wetting of the soil, considerably higher results were obtained. These results were in a fairly constant ratio to the results by the dry method, approximately 90% of the latter. The method failed to give theoretical values with pure organic substances. The ratios of the values obtained to the theoretical bore a similarity to the ratios obtained for soils. Reasons for the failure of the method to give 100% recovery are discussed briefly. G.R.S.

Change of phase and change of constitution in the solid state. R. B. SOSMAN. *Penn. State Coll. Mineral Ind. Expt. Sta. Bull.*, No. 14, pp. 11–27 (1933).—In the present consideration of phases two types are included under the designation of "solid," (1) resilient crystalline phases, and (2) glassy phases. The various structures and changes of constitution of the resilient crystalline phases are discussed. While it is recognized that no "change of phase" can occur in the glassy state, there is an abundance of evidence to indicate that changes in constitution and transformations do occur in the glassy state corresponding to those taking place in the crystalline state. S. points out that both crystalline and chaotic phases show some permanent departures from homogeneity that may be influenced by heat treatment. H.E.S.

Collation of experimental data. XXII–XXIII. A. ALISON. *Glass*, **12** [6] 254–56; [7] 305 (1935).—The occurrence of small errors and deviations in regard to experimental data is discussed. For Part XXI see *Ceram. Abs.*, **14** [10] 263 (1935). M.C.S.

Comparison between the suction method and the centrifuge method for determining the moisture equivalent of soils. G. J. BOUYOUCOS. *Soil Sci.*, **40** [2] 165–71 (1935).—Results show that the two methods agree closely in the majority of soils investigated, the suction method giving somewhat higher values than the centrifuge method. Both methods are empirical and give comparative results only. Since the suction method is simple, convenient, rapid, and infinitely more available, it should be of value where moisture-equivalent machines are not available. G.R.S.

Constitution of fused cements—the system CaO–Al_2O_3–SiO_2 and its application for the study of fused

cements. B. TAVASCI. *Chimica & Industria*, **17** [7] 461–71 (1935).—A microscopic mineralogical and a microscopic metallographic study (new for this purpose) are described; the latter was developed to distinguish between the different constituents. The results show that, contrary to the findings of Rankin and Wright, the compound $3CaO{\cdot}5Al_2O_3$ does not exist but instead the compound $CaO{\cdot}2Al_2O_3$, which has all the optical properties of the former and decomposes above about 1765°C into Al_2O_3 and a liquid. A diagram of the system CaO–Al_2O_3 is established. It is explained how the results can be applied to identify number and quality of the components of a fused cement. Four etching agents are given which develop the metallographic structure of the cement in 10 to 60 seconds. See also "Constitut¹on—" *Ceram. Abs.*, **14** [4] 87 (1935). M.H.

Crystal structure of γ-Fe_2O_3 and γ-Al_2O_3. E. J. W. VERWEY. *Z. Krist.*, **91**, 65–69 (1935).—The cubic spinel structure of γ-Al_2O_3 and γ-Fe_2O_3 is described as an average structure with regard to the cations. The oxygen arrangement is the same as in normal spinels. The unit cell contains 32 oxygen ions. Zeta Al_2O_3 was determined to be identical structurally with γ-Al_2O_3. H.I.

Determination of alkalis in feldspars. Modified hydrofluoric acid method. E. W. KOENIG. *Ind. Eng. Chem., Anal. Ed.*, **7** [5] 314–15 (1935).—A further modification of the Berzelius method for the disintegration of a silicate, preliminary to the isolation of the alkali metals as chlorides, has been successfully employed in the analysis of feldspar. Replacement of the J. Lawrence Smith procedure by the modified method entails no sacrifice in analytical accuracy and reduces the time required for an analysis. Reagent costs have been reduced and a more economical use of equipment has been attained. Possibilities of the application of the method to the analysis of other ceramic materials and products are encouraging, though they have not been investigated. F.G.H.

Determination of alkalis in silicates with special reference to high-alumina refractories. EDGAR B. READ. *Jour. Amer. Ceram. Soc.*, **18** [11] 341–46 (1935).

Determination of magnesium as magnesium ammonium phosphate hexahydrate. J. P. MEHLIG. *Jour. Chem. Ed.*, **12** [6] 288–90 (1935).—A method is given for the determination of magnesium by precipitating it as magnesium ammonium phosphate hexahydrate. Tables are given for results obtained by this method and by the pyrophosphate method, with which they compare favorably. The hexahydrate method is favored for its greater ease of execution. It is strongly recommended for the determination of phosphorus as well as magnesium. M.J.H.

Effect of pressure on eutectic mixtures. H. A. C. MCKAY AND B. HIGMAN. *Phil. Mag.*, **19** [126] 367–76 (1935).—Equations connecting eutectic temperature, eutectic composition, and the pressure are deduced. The equation giving change in composition with pressure is new and is applied to four systems with fair success. Mathematical. C.J.P.

Equilibrium diagram of the system BaF_2–MgF_2. M. OKAMOTO AND U. NISIOKA. *Sci. Repts. Tôhoku Imp. Univ.*, **24** [1] 141–49 (1935).—The equilibrium diagram of this system was determined using thermal and X-ray analyses, microscopic examinations, and measurements of density and refractive index. A compound, $BaF_2{\cdot}2MgF_2$, with 41.5% of MgF_2 is formed at 930°C. This system shows a eutectic point at 17% MgF_2 and 83% BaF_2 at 912°C. W.M.C.

Formation of rutile. HEINRICH RHEINBOLDT AND WERNER WISPFELD. *Ber. deut. chem. Ges.*, **17**, 375–76 (1934).—The authors, investigating the oxidation of titanium chloride vapor with molecular oxygen at high temperature (700°C), observed the crystallization of rutile in well-formed crystals. This crystallized TiO_2 was entirely free from chlorine and had a specific gravity of 4.24. L.E.T.

Fusion temperature of coal ash as related to composition. A. H. MOODY AND D. D. LANGAN. *Combustion*, **6** [8] 13–20 (1935).—Experimental data have been plotted so that the fusion temperatures of mixtures may be predicted. The effect of reducing gases has been shown in relation to composition of the ash. H.E.S.

Improved construction of gas-analysis apparatus. H. H. MÜLLER-NEUGLÜCK. *Brennstoff-Chemie*, **16** [7] 129–32 (1935).—Based on a large number of gas analyses, the following suggestions are made: (1) the Tramm pipet is recommended for its favorable washing effect; (2) the iodine pentoxide-fuming sulfuric acid method for determining CO is better in many ways than other methods; (3) by the use of a special container for the iodine pentoxide pipet, this method can be applied in portable apparatus; (4) a double-tube measuring buret is much shorter and equally as accurate as the single-tube buret. Illustrated. E.J.V.

Indirect determination of sodium and potassium in alkali-lime-silica glasses. O. K. *Sprechsaal*, **68** [14] 212–13 (1935).—Directions for three indirect analysis methods for a quantitative determination of Na and K in glasses are given. M.V.C.

Influence of the proximity of a solid wall on the consistency of viscous and plastic materials. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. *Jour. Phys. Chem.*, **39** [7] 973–81 (1935).—Measurements of the flow rates of aqueous pastes through narrow glass tubes indicate that the proximity of the wall causes a sheath of the material to shear more easily than the bulk of the material. Soils, clays, and finely divided materials are used. C.J.P.

Law of phases and equilibrium diagrams in the study of industrial silicates. LEON FRANCQ. *Verre & Silicates Ind.*, **6** [15] 274–77 (1935).—Crystallization in 3-component systems without solid solutions and in 3-component systems with solid solutions and 4-component systems are discussed. See *Ceram. Abs.*, **14** [11] 293 (1935). M.V.C.

Method of estimating exchangeable bases in soils. A. N. PURI. *Soil Sci.*, **40** [2] 159–63 (1935).—Ammonium carbonate was shown to be a useful reagent for estimating exchangeable bases in soils. By the method outlined the determination of exchangeable bases was reduced to simple titrations, thus making possible such estimations with the minimum of equipment and skill. The method is especially suitable for the study of saline, alkali, and calcareous soils, which have always presented peculiar difficulties in such estimations. G.R.S.

Modification in the confirmatory test for zinc ion.

MARGARET W. KELLY AND ELISABETH L. JOHNSON. *Jour. Chem. Ed.*, **12** [10] 481–83 (1935).—A new qualitative test for zinc ion is described, based on the fusion of zinc nitrate with solid ammonium nitrate. Color reactions for varying amounts of zinc ion present are given. M.J.H.

Oxyquinolate method for determining aluminum, iron, and titanium. L. STUCKERT AND F. W. MEIER. *Sprechsaal*, **68** [34] 527–29 (1935).—An exact retesting of the oxyquinolate method for determining aluminum, iron, and titanium showed the reliability of this method. It is necessary, however, to separate silica, either by ordinary methods (perchloric acid method) or by evaporating to dryness with a solution of hydrofluoric or sulfuric acid. The titrimetric determination of the metals by means of bromate-bromide solution yields exact values with pure or titanium-containing aluminum salt solutions, but for iron solutions the values are too low. The indirect method by retitrating the surplus oxyquinoline is unusable. The oxyquinoline method is very valuable for the silicate industry because of its simplicity and exactness, provided directions are carefully followed. M.V.C.

Products of hydrothermal reaction on clayey substances: I. S. NAGAI AND T. YOSHIURA. *Jour. Soc. Chem. Ind.* [Japan], **38** [8] 371–73*B* (1935).—Tables are given showing (1) analyses of the clays, (2) results of hydrothermal heating of clay substances with sodium hydroxide solution under pressure of live steam, and (3) the results of analyses of chemical compositions and rational formulas of the heated products. M.V.C.

Progress in heat treatment of alloys resulting from structure studies. D. F. MCFARLAND. *Penn. State Coll. Mineral Ind. Expt. Sta. Bull.*, No. 14, pp. 67–76 (1933).—The progress of metallurgy is briefly traced from early crude heat treatment through the introduction of metallography and the development of physical metallurgy. The constitution of alloys, crystalline structure, the various forms of heat treatment, and the results of age hardening of metals and metal alloys are discussed. M. also points out that since the analogy between ceramic materials and metals is often very close and since the same fundamental physical laws apply to both fields, it may be expected that equally remarkable developments may be brought forth by continued research in the field of physical ceramics. H.E.S.

Rapid determination of alumina by the oxyquinoline method. PAUL KOCH. *Ber. deut. keram. Ges.*, **16** [3] 118–27 (1935).—Koch criticizes the method proposed by Klasse (*Ceram. Abs.*, **14** [6] 151 (1935)), the points raised being the use of an empirical formula and the disregard of titanic acid. Klasse's reply is given. E.J.V.

Removal of bubbles from old thin-sections of rocks. W. D. KELLER. *Amer. Mineralogist*, **20** [7] 540 (1935).—Xylol was used to dissolve the excess cement after the cover had been removed from the imperfect slide. F.J.Z.

Revisions of high temperatures. L. DONALD MORRIS AND S. R. SCHOLES. *Jour. Amer. Ceram. Soc.*, **18** [11] 359–60 (1935).

Single-phase systems as the basis of scientific ceramic research. EUGEN RISHKEVICH. *Ber. deut. keram. Ges.*, **16** [3] 111–17 (1935).—Ceramic research is in its present backward position mainly because attention has been directed to complicated polyphase systems, sometimes not even in a state of equilibrium. By contrast, in metallography there would have been much less progress had only highly complicated systems, such as in ceramics, been available. The ceramic technologist is in a position to work with single-phase systems and taking advantage of this should lead to the establishment of a "ceramography." E.J.V.

Sodium sesquisilicate, its detergent applications. C. H. JEGLUM. *Soap*, **11** [2] 31 (1935).—Sodium sesquisilicate is the newest alkali to be presented for sale. A comparison of this compound with sodium metasilicate is made. M.J.H.

System Fe–P–O. H. WENTRUP. *Arch. Eisenhüttenwesen*, **9**, 57–60 (1935).—The equilibrium diagram of the system Fe_2O_3–P_2O_5 was investigated from 30 to 50.6% Fe, and the system FeO–P_2O_5 from 46.9 to 59.8% Fe. The probable diagram of the system $3FeO{\cdot}P_2O_5$–$2Fe_2O_3{\cdot}3P_2O_5$ is presented. W.M.C.

Thermal conductivity of quartz at low temperatures. W. J. DE HAAS AND TH. BIERMASZ. *Physica*, **2** [7] 673–82 (1935).—The thermal conductivity of quartz // to the axis is investigated for the range 16° to 87°K. The conductivity at low temperatures decreases rapidly, much as in the case of pure metals, and is strongly dependent on lattice impurities. C.J.P.

Thermodynamics of base-exchange equilibria of different kinds of clays. J. KIELLAND. *Jour. Soc. Chem. Ind.*, **54** [28] 232–34(1935).—A brief outline of a thermodynamic method of treating base-exchange equilibria is given, taking into account the activity coefficients of the zeolite components. Constant log *K* values were obtained by this method. Thus the problem of correct mathematical expression of base-exchange equilibria has been solved. Preliminary values for the free energies of nine zeolites are given. It was shown that the intermediate compound, $2HZ,TlZ$, occurs in exchange reactions between H^+ and Tl^+ in some kinds of clay. The free energies of HZ, $2HZ$, TlZ, and TlZ were calculated. There is only a slight difference in the figures obtained from measurements of the base-exchange equilibria of bentonite and Putnam clay. G.R.S.

Titrimetric determination of copper. ERICH BOYE. *Ber. deut. chem. Ges.*, **67**, 1119–21 (1934).—B. obtained very satisfactory results by treating a boiling, slightly acid, copper solution with hydroxylamine sulfate and then titrating the cooled solution with rhodamide solution. L.E.T.

Two-dimensional cristobalite crystals. W. NIEUWENKAMP. *Z. Krist.*, **90**, 377–80 (1935).—The structure of cristobalite crystals which are pseudomorphous after tridymite is described. H.I.

Volumetric method for the determination of sulfate in natural water and boiler blowdown using potassium palmitate. P. HAMER. *Jour. Soc. Chem. Ind.*, **54** [30] 250–53 (1935).—A rapid and simple volumetric method of determining sulfate in natural waters and boiler blowdown employing potassium palmitate is described. Good agreements with gravimetric methods are given. The use of potassium palmitate may be extended to other cases in which a determination of sulfate is required. G.R.S.

Volumetric oxidizing agent. PHILENA YOUNG. *Jour. Chem. Ed.*, **11** [8] 466–70 (1934).—The properties of ceric sulfate as a volumetric oxidizing agent are given together with a discussion of the properties of other oxidizing agents such as potassium permanganate and dichromate. The preparation of ceric sulfate solutions for volumetric work is also discussed. The determination of iron in an iron ore is one of the most valuable uses to which ceric sulfate has been put. It is also used in determinations of calcium, arsenic, antimony, certain less common ions, organic acids, and thiosulfate solutions. M.J.H.

X-ray study of the system K_2SO_4–$MgSO_4$–$CaSO_4$. LEWIS S. RAMSDELL. *Amer. Mineralogist*, **20** [8] 569–74 (1935).—X-ray examination of fused mixtures of K_2SO_4, $MgSO_4$, and $CaSO_4$ revealed a continuous isomorphous series with $K_2Mg_2(SO_4)_3$ and $K_2Ca_2(SO_4)_3$ as end-members. No other compounds were found. The members of this series are simple cubic, with four molecules in the unit cell, and the length of the cube edge varies from 9.96Å for the Mg to 10.37 Å for the Ca end-member. The data from this system suggest an explanation concerning the extraction of K_2SO_4 from calcined polyhalite. F.J.Z.

BOOKS

Fundamentals of Chemical Thermodynamics: Part 1, Elementary Theory and Electrochemistry. J. A. V. BUTLER. 2d ed. xv + 253 pp. Macmillan and Co., Ltd., London, 1935. Price 7s 6d. Reviewed in *Nature*, **136** [3433] 244 (1935). J.L.G.

International Conference on Physics, London, 1934. Organized jointly by the International Union of Pure and Applied Physics and the Physical Society (London). 3 vols. University Press, Cambridge, 1935. **Papers and Discussions: Vol. I, Nuclear Physics.** 183 pp. The subjects covered are general quantum theory, natural β-decay, artificial radioactivity, disintegration and synthesis of nuclei and elementary particles, and cosmic radiation. The many excellent papers included, most of which contain hitherto unpublished information, will be of great interest to specialists in nuclear physics but will be of little use to ceramists. **Vol. II, The Solid State of Matter.** 257 pp. This part contains papers dealing with the structure of molecules and of the ideal lattice, deviations of real crystals from the ideal lattice structure, and plasticity and strain hardening in crystals. Although intended primarily for physicists and containing little of value to ceramists, this volume may prove to be of interest to engineers who are following the theoretical discussions on the mechanical strength of materials. **Reports on Symbols, Units, and Nomenclature.** 40 pp. This small volume contains three reports of the International Union of Physics Commission on Symbols, Units, and Nomenclature. The first, which deals with standard thermal units, makes the following recommendations: (*a*) that the unit of heat, when measured in units of energy, be the joule defined as 10^7 ergs, (*b*) that the gram-calorie is the amount of heat required to raise the temperature of one gram of air-free water from 14.5° to 15.5° of the international scale of temperature under the pressure of one normal atmosphere. The second report, which is the longest, deals with electric and magnetic units. The third covers the use of thermodynamic symbols and recommends the following: for entropy, S or ϕ; for internal energy, U or E; for free energy (Helmholtz free energy), F; for thermodynamic potential (Gibbs zeta function or the Lewis free energy), G; for work, W; and for total heat content (enthalpy), H or I. J. B. AUSTIN

Logarithms Numerical and Graphical for the Easy and Accurate Calculation of Commercial and Technical Problems. N. R. CORKE. Gee and Co., Ltd., London, 1934. 79 pp. Price 8s 6d. Reviewed in *Mech. Eng.*, **56** [10] 633 (1934). F.G.H.

Origins and Development of Applied Chemistry. J. R. PARTINGTON. Longmans, Green & Co., London, 1935. xii + 597 pp. Price 45s net. Reviewed in *Nature*, **136** [3434] 277 (1935).—Sources and uses of materials from the earliest times until the end of the Bronze Age are considered. A 65-page index of contents is included. J.L.G.

Physics of Solid Body. V. D. KUZNETSOV. Pub. House "Kubuch," Tomsk, 1932. 504 pp. Price 13R 15k. This is a valuable contribution, especially from the standpoint of education, treating the subject in an instructive and systematic way. The ten chapters deal with the following topics: basic data on crystallography; crystallization from solution and dissolution; crystallization from melts, super-cooling, polymorphism; surface energy of crystals; hardness of crystals; plasticity and strength of crystals of rock salt; influence of different factors on mechanical properties of crystals of rock salt; plasticity and strength of monocrystals; influence of temperature and other factors on the strength and plasticity of metallic monocrystals; some questions of physics of polycrystalline metals. A list of literature sources is given with every chapter. Subject and author indexes are appended. Illustrated. S. I. PERKAL

Principles of Phase Diagrams. J. S. MARSH. McGraw-Hill Book Co., New York, 1935. xiv + 193 pp., 180 figs. Price $3.00. The purpose of this book is to provide an explanation of phase diagrams adequate for the purpose of students who are primarily interested in the application of such diagrams. The book consists essentially of two parts: (1) a section on fundamentals which describes briefly the thermodynamic principles which serve as a basis for phase diagrams, and (2) a section which describes the principal types of phase diagrams which may be encountered. A section of 70 pages devoted to fundamentals, which includes discussions of such topics as the equation of state, thermodynamic potential, fugacity, relation of perfect to nonperfect solutions, and the definition of terms essential to the phase rule, must necessarily be extremely brief and the ordinary student will require much more extensive reading in thermodynamics.

The section devoted to the description of types of diagrams is a model of conciseness and deserves study by those experienced in the reading of equilibrium diagrams as well as the novice. Systems of one and two components are covered in one chapter, while two chapters are given to ternary diagrams. A new system of nomenclature is introduced which is unquestionably an improvement on the group of confused and haphazard terms commonly used to describe the parts of phase diagrams. More space might profitably be given to the use of the lever principle in determining relative amounts of phases, particularly, in ternary diagrams, in the determination of

amounts of phases already precipitated as well as the total composition of phases precipitating on a boundary curve at a given temperature. The author's unique method of distinguishing between eutectic invariant and noneutectic invariant points in ternary systems is of interest. The book should be of value to all students of phase diagrams.

HERBERT INSLEY

Text-Book of Physical Chemistry: Vol. 2, Principles Involved in Chemical Reactivity. J. NEWTON FRIEND. Charles Griffin and Co., Ltd., London, 1935. xii + 483 pp., 3 plates. Price 24s. Reviewed in *Nature*, **136** [3428] 51 (1935).—The principal subjects considered are thermochemistry, chemical equilibrium, reaction velocity and chemical change in homogeneous systems, combustion in gases, the phase rule, catalysis, electrochemistry, structure of the atom and of the molecule, and chemical thermodynamics. For Vol. I see *Ceram. Abs.*, **12** [10–11] 404 (1933). J.L.G.

Text Book of Quantitative Chemical Analysis. A. C. CUMMING AND S. A. KAY. 6th ed., revised by F. C. Guthrie and J. T. Nance. Gurney and Jackson, London and Edinburgh, 1934. xv + 482 pp. Price 15s net. Briefly reviewed in *Nature*, **135** [3425] 1020 (1935).—The increased use of electrolytic and colorimetric methods is given special attention. Chapters on the analysis of ores and alloys, gas, and water have been added. J.L.G.

PATENTS

Ceramic masses preventing the formation of carbon deposits. HANS WOLF AND HERMANN LEUCHS (I. G. Farbenind. A.-G.). U. S. 2,020,713, Nov. 12, 1935 (Aug. 4, 1931). Ceramic masses containing iron or iron oxide to be used in conjunction with hot gases containing carbon compounds and in which no carbon is deposited from the gases containing carbon compounds when coming into contact therewith at high temperatures, the ceramic masses containing an amount of a copper compound not exceeding 0.2% of their weight calculated as metallic copper.

Method of producing crystalline hydrates of alkali-metal silicates. C. L. BAKER (Philadelphia Quartz Co. of California). U. S. 2,017,561, Oct. 15, 1935 (July 18, 1931). In a method of making a definite crystalline hydrate of an alkali-metal silicate, the steps include preparing a solution of the hydrate, establishing the solution at a temperature below the melting point of the crystal sought but high enough to keep the solution relatively fluid, initiating crystallization while substantially maintaining the temperature, mechanically separating the crystals from the liquor without material reduction of the temperature, and, therefore, of the fluidity of the residual mother liquor, and drying the separated crystals at substantially the same temperature.

Method of recovering lithium from its ores. WALTER ROSETT AND F. R. BICHOWSKY. U. S. 2,020,854, Nov. 12, 1935 (Oct. 6, 1933). A process for recovering lithium from its ores consists of the steps of intimately mixing comminuted ore with a calcium-containing material that yields calcium oxide, at least in part, on roasting, roasting the mixture at 800° to 1000°C until clinkered, reducing the coarse clinker to a suitable size for leaching, leaching the clinker with hot water until the clinker is free of alkali salts, precipitating as a carbonate the calcium contained in the liquor, separating the liquor from the carbonate, and adding to the liquor an acid to form the desired salt of lithium.

Process of making sodium aluminate. R. E. CUSHING AND C. W. BURKHART (Pennsylvania Salt Mfg. Co.). U. S. 2,018,607, Oct. 22, 1935 (Nov. 10, 1934). The process of preparing solid sodium aluminate by reacting powdered alumina hydrate and solid caustic soda directly without aqueous dissolution or fusion of the caustic soda comprises mixing together powdered alumina hydrate and solid caustic soda, in the absence of sufficient added water to dissolve the caustic soda, and reacting the mixture of solid materials at a temperature insufficient to fuse the caustic soda.

Production of alkali perborates. N. V. INDUSTRIEELE MAATSCHAPPIJ VOORHEEN NOURY & VAN DER LANDE. Brit. 434,991, Sept. 25, 1935 (Aug. 9, 1933).

Zirconium silicon alkali acid solution and method for stabilizing. C. J. KINZIE (Titanium Alloy Mfg. Co.). U. S. 2,017,125, Oct. 15, 1935 (July 27, 1932). A method of converting zirconium silicate or zircon into a stabilized acid zirconium solution containing silicon and an alkali metal comprises decomposing the zirconium silicate mixed with the alkali through heating, treating the roasted product with nitric acid to solution of silicon and soluble zirconium compounds, separating the clear acid liquor containing zirconium, silicon, and alkali in solution, and adding a readily water-soluble organic compound selected from the group consisting of tartaric acid, citric acid, and sodium zirconium tartrate to stabilize it.

General

After the flood. G. A. VAN BRUNT. *Factory Management & Maintenance*, **93** [9] 400–401 (1935).—Electrical equipment that has been submerged in flood waters requires prompt and careful treatment to avoid serious damage. All dirt, grease, and oil should first be removed before sending small motors to the repair shop. Large motors can be dried in place. All bearings should be cleaned thoroughly to remove the silt usually contained in flood waters. All transformer oil should be filtered. Motor and transformer windings should be dried at temperatures not exceeding 85°C. If coils are dried, not in ovens but by passing low-voltage current through them, care must be taken to avoid producing hot spots inside the coils. Resistance tests on insulation will indicate when the drying is complete and if the insulation has been permanently injured. Before putting in service again, windings and conductors should have two or three coats of air-drying varnish. Speed reducers, chain drives, and gears should be cleaned carefully of grit, dirt, and oil. Rubber belts usually suffer no harm from water and are ready for service after cleansing from grit and drying the surface. If water penetrates through cuts to fabric under the rubber, such places must be cut out. Wet leather belts should be cleaned and coated with belt dressing on both sides to insure that they dry slowly. Such drying should not be hastened by the application of heat. Waterproof

fabric belts require only cleaning and surface drying before use. If they have been submerged too long, however, they may shrink on drying and put undue tension on shafts and bearings. Nonwaterproof fabric belts should be removed from pulleys and stretched flat to dry under tension since they shrink considerably. After machines have been cleaned and reassembled, they should be tested for alignment and accuracy and the bearings run in for a short time. Illustrated by photos taken at the Corning Glass Works during the flood of July 7 and 8, 1935. J.L.G.

Anomalies of siliceous matter in boiler-water chemistry. R. E. SUMMERS. *Combustion*, **6** [7] 13–15 (1935).—S. discusses several apparently divergent views of authorities concerning theories of siliceous scale prevention. He points out that hardness is not an index of the tendency of siliceous water to incrust boilers, that the use of evaporators does not insure the complete elimination of such matter, and that higher p_H values are desirable with high silicate content of boiler water; furthermore, increased rate of blowdown usually results in increased rate of scale accumulation under such conditions. H.E.S.

Ceramic collection in Rome. L. ARIMATTEI. *Ind. Vetro Ceram.*, No. 8, pp. 327–29 (1935).—A collection of about 200 majolica pieces is described. The Spanish Moorish group dates from the 15th to the 17th Century, and the Italian, particularly important, from the 14th to the 18th Century. Some specimens are unparalleled. F.E.V.

Dust problem. ANON. *Ceram. Ind.*, **24** [5] 263–66 (1935).—Special mechanical and medical precautions taken in a newly designed pottery plant to avoid dust conditions are described. Illustrated. E.J.V.

Economics of preheated air for stokers. R. E. DILLON AND M. D. ENGLE. *Combustion*, **6** [7] 17–20 (1935).—Maintenance data are supplied by 33 operating companies covering 122 underfeed stokers operating with average air temperatures of 120 to 460°F and maximum air temperatures as high as 600°F. Aside from preheat temperatures, the factors affecting stoker maintenance are area of stoker, coal burned per square foot per hour, and per cent of ash in the coal burned. Up to 300°F the preheating of air supplied to underfeed stokers does not seem to increase maintenance above reasonable figures, but above 300° or 350°F there is a sharp increase in maintenance. H.E.S.

Effects of adverse atmospheric conditions encountered in various industries on mental and muscular efficiency. G. E. GLOCK. *Jour. Hygiene*, **35** [1] 78–92 (1935).—The observations were made in an air-conditioning hut with control of circulation, humidity, and temperature. The subjects were dressed in a standard uniform, and their diet was controlled. Measurements under different conditions were made of their pulse rate, blood pressure, blood sugar, respiration rate, metabolic rate, mental efficiency, and muscular efficiency. It was found that the physiological reactions produced by alterations in the atmospheric conditions closely followed the subjective sensations experienced. Bad air conditions produced an increased pulse rate, respiration rate, and metabolic rate, and a decreased blood pressure, and decreased muscular and mental efficiency. To produce normal physiological factors, a wind of 200 ft./min. was required. G.H.A.

Fatal case of silicosis. S. V. GUDJONSSON AND C. J. JACOBSON. *Jour. Hygiene*, **34** [2] 166–71 (1934).—A typical uncomplicated case of silicosis is described. Up to the time of his death the worker was a porcelain turner in a Copenhagen factory. His work was mainly with wet or moist clay but also required putting the finishing touches to the dry pieces of pottery. Samples of dust taken from the works contained a considerable proportion of free silica. A Roentgenographical examination of the worker 16 months previous to death showed silicosis in the third stage. The findings on autopsy are given in detail. No tuberculosis was found in any of the sections. Microscopic examination of lung tissue showed numerous needles of sericite and needles from kaolin. The findings support the theory advanced by W. R. Jones that silicosis can be produced by fibrous minerals. In a comprehensive examination of porcelain workers in Denmark many were found to present marked silicotic changes in the lungs. Illustrated. G.H.A.

Glass enemy No. 1. ALEXANDER SILVERMAN. *Glass Ind.*, **16** [10] 305–309 (1935).—S. discusses the present Tariff Act and its failure to protect the glass industry, with special reference to false invoicing, false entering, and improper classification, and suggests possible means for overcoming these. E.J.V.

Importance of dust abatement in cement manufacture. P. POUTIER. *Génie Civil*, **104** [12] 267–70 (1935).—Large amounts of dust produced during the manufacture of cement are objectionable both from the economic and health standpoints. Means for the reduction of its amount and for the recovery of the dust produced are described. Filtering of the outcoming air is the best solution. Mechanical filters offer several objections. Electrostatic precipitation was used with pronounced success on the plant scale. Cottrell Lurgi apparatus appear to be the best. J.D.G.

Influence of improved design on marketing strategy. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **14** [11] 375 (1935).

International Congress on Glass Technology, 1936. ANON. *Bull. Amer. Ceram. Soc.*, **14** [11] 375–76 (1935).

Inventory control. H. P. DUTTON. *Factory Management & Maintenance*, **93** [8] S77–92 (1935).—The article is divided into chapters entitled (1) need to overhaul current practice, (2) speculative elements, (3) economic lot sizes, (4) perpetual inventory records, (5) taking physical inventory, (6) pricing materials, (7) layout of the stockroom, (8) symbolization of materials, (9) organization and personnel, and (10) measures of storeroom performance. Illustrated by charts, graphs, and a photo. J.L.G.

Manganese occupational poisoning. V. DHERS. *Méd. du Travail*, **6**, 63–94, 147–94 (1935); abstracted in *Chem. Eng. Mining Rev.*, **27**, 408 (1935).—The symptoms of poisoning by MnO_2 and other Mn compounds are described. Since treatment is useless, it is important to exclude the dangerous dust from the air of workshops. H.H.S.

Method of expressing the silica content of the lung. D. H. COLLINS AND J. H. DIBLE. *Jour. Hygiene*, **35** [1] 64–68 (1935).—Four methods are used: (1) per cent of moist weight of the organ, (2) per cent of dry weight, (3) per cent of mineral ash, and (4) total silica. The merits of each method are discussed. It is concluded that estima-

tion as total silica is the method least liable to errors. The quantity of silica recoverable from samples of lung may be valuable evidence on autopsy of contributory, pulmonary fibrosis. G.H.A.

Mines Branch laboratory and field program. EDITORIAL. *Can. Mining Met. Bull.*, No. 281, pp. 423–26 (1935).—Current activities of the Dominion Government Mines Branch are outlined. The Ceramics Division is testing the physical properties of Canadian brick, especially in reference to their weather-resisting properties, and is investigating the treatment of certain shales used in brickmaking in an effort to reduce the porosity, as well as conducting a number of minor investigations. G.M.H.

Oil, trail blazer for business. EVERETT T. MARTIN. *Nation's Business*, p. 46 (Aug., 1934).—The oil industry, its birth, development, present expanse, and probable future, is discussed. Technical obstacles and their solutions are outlined. P.T.C.

Operating time and trouble saved. SABIN CROCKER. *Heating, Piping, & Air Conditioning*, **7** [7] 331–32 (1935).—C. shows how operating time and trouble can be saved by considering coal and ash handling and accessibility for repairs and operation in the installation of single-retort underfeed stokers in medium-sized boilers. Five photos of actual installations are shown. J.L.G.

Practical interpretations of feed-water tests. C. W. RICE. *Combustion*, **6** [8] 29–32 (1935).—R. points out how simple, daily, routine tests by the operating engineer for controlling the water conditioning can be utilized to reveal much additional information, *e.g.*, the condition of the boiler, leaky blowoff connections, whether the blowdown is excessive, waste in carryover, ratings being carried, and the detection of pending trouble. In these the salt and alkalinity readings are indicative. Examples are included. H.E.S.

Preparation of raw materials for ceramics. G. GERTH. *Sprechsaal*, **68** [27] 419–22 (1935).—By preparation is understood the separation of the useful minerals from those that accompany them in deposits. This includes mechanical processes by the wet method, flotation, magnetic separation, and centrifuge. The cases in which these processes are used in the preparation of ceramic raw materials are described. M.V.C.

Preventing belt static. WAYNE DAVIES. *Factory Management & Maintenance*, **93** [8] 355–56 (1935).—Dangerous static charges can be prevented by proper drive design and by keeping belts soft and pliable. Proper ventilation will usually prevent static charges from building up since the open air is normally too humid to allow static charges to develop. When the generation of static charges can not be prevented, the machines and surrounding handrails should be grounded as should the jack- and line-shaft hangers. A good practical ground for a belt or machine likely to develop static charges consists of two small flat pieces of carbon with a thin sheet of pure mica between them. The mica sheet should have a $^{3}/_{16}$-in. hole through its center. A charge carried to one plate from the belt or machine will cross the gap to the other carbon plate and be grounded without sparking. Two needle points may be used as a rough voltmeter in testing for static voltages, remembering that 20,000 v. will cause a discharge to jump an inch gap in the air and that the voltage is directly proportional to the distance the spark jumps. Humidity below 30% favors the development of static charges; 40 to 50% and above will generally prevent the build-up of dangerous static charges. Illustrated. J.L.G.

Properties of crystalline magnesium oxide. R. W. DITCHBURN AND J. HARDING. *Nature*, **136** [3428] 70–71 (1935).—D. and H. sealed artificial crystals of MgO into soda glass and obtained vacuum-tight seals. The edges of the crystal should be polished before sealing in. Thermal expansion coefficient of the crystal is 11×10^{-6} and that of the glass used is 9.6×10^{-6} in the range 0 to 100°C. Crystals were about 1 x 1 x 0.5 cm. with some up to 3 x 3 x 1 cm. Clear specimens were transparent to λ 2200Å. Most specimens showed some double refraction due to strains. The crystals seem impervious to attack by lithium, potassium (400°C), sodium (500°C), lead (1050°C), magnesium (1100°C), and aluminum (1100°C), but calcium (1050°C) and copper (1100°C) etched the surface slightly. They are thus more resistant to penetration by metal vapors than either glass or quartz. J.L.G.

Quality control. H. P. DUTTON. *Factory Management & Maintenance*, **93** [9] S93–108 (1935).—Quality control insures that the customer always receives satisfactory goods and calls attention to points or processes where a control is failing to act and a correction is needed. The following subjects are considered: (1) objective of quality control, (2) inspection specifications, (3) where and what to inspect, (4) inspection by sampling, (5) inspecting the inspector's work, (6) tools of inspection, (7) layout of inspection operations, (8) inspection organization, (9) managing the department, and (10) applications of inspection. Illustrated by graphs. J.L.G.

Quality control. F. M. THORMAN. *Bull. Amer. Ceram. Soc.*, **14** [11] 355–59 (1935).

Silicates of soda in the ceramic industry. J. G. VAIL. *Ceram. Age*, **23** [1] 3–4 (1934).—A brief classification of sodium silicates with respect to physical form, water content, and chemical composition is given. The following applications of sodium silicates are described: (1) deflocculation of clays, (2) composition of acidproof, fritted enamels, (3) cleaning of sheet steel, (4) preparation of glazes, (5) bonding of abrasive wheels, and (6) manufacture of refractory cements. See also "Sodium silicate—" *Ceram. Abs.*, **13** [9] 246 (1934). F.G.H.

Silicosis—industrial enemy. C. O. SAPPINGTON. *Factory Management & Maintenance*, **93** [7] 291–92 (1935).—S., a doctor and consulting industrial hygienist, defines silicosis as a general replacement of normal, elastic lung tissue by unyielding, inelastic fibrous tissue brought about by continuous breathing of microscopic particles of free silica dust for an extended period of time. This fibrous tissue causes a shortness of breath, a decrease in lung expansion, and an increased tendency to tuberculosis. Nature's primary defenses against silicosis are the hairs in the nose, the mucous secretion on the surface of the lining of nose, throat, and windpipe, and the cilia or microscopic hairs on the lining of these passageways. The secondary defense is the so-called lymphatic system which acts to carry waste from the lungs. The four exposure factors involved in the production of silicosis are (1) the concentration of the dust (number of particles per cubic foot of air), (2) size of the dust particles (particles under ten mi-

crons in largest diameter are considered to cause silicosis since no larger ones are able to enter the tiny air sacs of the lungs), (3) mineral composition of the dust with quartz the dangerous constituent, and (4) length of time exposed to the dust. A rating of the health hazards of a particular plant can be made only after considering the physical conditions of the plant, the processes and materials, duties of the employees, their previous medical and occupational histories, the four exposure factors listed, and the medical findings on employees. This last should include a thorough history and examination of the chest, with stereoscopic X-ray films. Medical methods of prevention include preëmployment examinations with chest films, periodic examinations with chest films, and placement of employees according to the results of these examinations. Engineering prevention includes making dust analyses, rating the efficiency of protective devices, and comparing the information gained with the established criteria. The protection used may take the form of protection for individual employees or of control of the dust particles. The measurement of the remaining hazard is not concerned with what the protective devices take away but rather with what remains for the worker to breathe. Illustrated.

J.L.G.

Steel prepares to meet new opportunities. V. G. Iden. *Nation's Business*, p. 22 (March, 1934).—Numerous examples of the applications of stainless steels, sheet steels, and improved welding methods are given, and it is shown how these advances have lead the steel industry, the business barometer, back toward better times.

P.T.C.

Views on silicosis. W. E. Cooke. *Jour. Hygiene*, 35 [2] 207–18 (1935).—It is claimed that the consensus of opinion is that the chemical action of free silica plays the major part in the production of silicosis. The theory of W. R. Jones that sericite and not free silica is the cause of silicosis is discredited. The size of the particles is important only on account of their effect on the solubility. Sharp and angular particles do not necessarily cause respiratory disability. Pneumonoconiosis from asbestos may be due to the liberation of free silica from solution of asbestos in tissue fluids. No explanation is given for the immunity from silicosis of some workers under adverse conditions.

G.H.A.

BOOKS

Ceramic Data Book and Catalogs. 8th ed. Industrial Publications, Inc., Chicago, 1935. 330 pp. No charge. This edition carries 80 pages of well-illustrated advertisements, each of which contains informational matter of value to every ceramist. These 80 pages of advertising are not by any means of small value; they are sources of information. There are 44 pages devoted to a review of the literature with bibliographies on enamel, whiteware, glass, refractories, and structural clay products and production. There are 150 pages devoted to a compilation of tables, charts, definitions, and data which are frequently used. Forty-five pages are devoted to ceramic raw materials. Eleven pages are devoted to formulas and calculations. While some of the material of this eighth edition appears in the previous editions, a great deal of it is new, bringing the information up to date. This has characterized all previous editions, making of these books valuable and fairly exhaustive reference works on ceramics.

Ross C. Purdy

Ceramic Engineering (Ingeniería Cerámica). T. W. Garve, Columbus, Ohio. 8 pp., 11 figs. This small bulletin discusses driers, kilns, etc., and is written for the needs of the clayworker in Latin-American countries. It contains an improved design of a chambered continuous kiln especially suitable for the prevailing capacities and requirements of the Spanish and Portuguese South. This kiln permits the firing of all structural and other ware, enabling flashing, salt-glazing, etc. An appendix contains a table of pyrometric cones and other vital data relative to the conversion from the English to the metric (Spanish) system.

T.W.G.

Chemical Engineering Catalog. 20th annual ed. Reinhold Publishing Corp., New York, 1935. 863 pp. Price $3.00. The publishers have once more rendered valuable service to the industries in the issuance of this book. The technical and scientific book section of 50 pages is alone worth the price of this catalog. The many equipment and instrument concerns have furnished 800 pages of condensed alphabetized and indexed catalog, thus providing a handy reference book. It has a separate index of the laboratory and reagent chemicals.

Ross C. Purdy

Chemical Guide Book, 1935. Chemical Markets, Inc., New York, 1935. 803 pp. Price $2.00. Reviewed in *Ceram. Age*, **26** [4] 159 (1935).

F.G.H.

Dynamic Economics. Theoretical and Statistical Studies of Demand, Production, and Prices. (Monograph of the Cowles Commission for Research in Economics, No. 1). Charles Frederick Roos. Principia Press, Bloomington, Ind., 1934. 275 pp. Price $3.50. A good general description of this book by the former Director of Research and Planning of the NRA is found in the first sentence of his preface. "In 1929 I decided to refrain from publishing research papers in economics until I had a sufficient number to justify the publication of a book which would relate these researches to each other and to my earlier papers." Unfortunately, R. has not quite succeeded in all he set out to do, for in spite of certain points of correlation between the chapters they remain a collection of research studies lacking in continuity and of uneven quality, the more mathematical ones being, in general, superior to the others. This is partly due to the fact that, like Alfred Marshall whom he quotes, R. obviously thinks' 'much more easily in mathematics. . .than in English." His text is not well finished and is sometimes wordy, as in the case of Chapter I, in which he takes 12 pages to develop the concept of "dynamic economics" which must be clear to anyone who is competent to understand what follows. There is also a tendency to overwork certain symbols which occasionally leads to confusion. For example on page 196, reference is made to the letters *A*, *B*, and *C* without further comment except that they are "described in the preceding chapter," which in turn seems to contain several kinds of *A*'s, *B*'s, and *C*'s.

In regard to subject matter, R., whose mathematical equipment is impressive and beyond question, has attempted to provide a broad basis for economic theory and in so doing has made frequent excursions into highly ab-

stract fields, *e.g.*, functional analysis and the use of Volterra integrals, so that unless the reader is familiar with these specialized fields he is likely to find himself lost for the rest of the chapter. Since mathematics is nothing more than a machine operating on a set of postulates as raw materials, the real value of the conclusions derived depends on the validity of the statistics used and of the assumptions introduced. R. has been more careful than most authors in making these premises clear, but the reviewer suspects that the data and assumptions used will not find universal acceptance among economists.

The chapters on "Automotive Demand for Gasoline" and "Factors Influencing Residential Building," which have already been presented before the Econometric Society, seemed to be particularly interesting, chiefly because they are more concrete than most of the others. It is interesting to note that these chapters are based on work done at the NRA. Another sidelight on NRA activity is provided by the chapter on "Exchange in a Capitalistic Economy," the unfinished manuscript of which enabled the author to meet a request for "an equation of exchange in a capitalistic economy"—to be furnished in 24 hours!

Among the interesting conclusions reached are the following: ". . .the theory of demand has progressed to a point where it is questionable that further theoretical work should be done until many statistical studies have been made to verify or disprove the hypotheses and conclusions so far reached." "It is entirely sound and, under certain restrictions, socially desirable economics to permit the practice of using loss leaders. . . . The net effect is to increase the consumption of the loss leader and of the companion commodity and at the same time to give the merchants greater profits." "Either a capitalistic economy or a socialistic one will work, but it is extremely difficult to mix the two."

The demonstration of the psychological effect of a sales tax on gasoline is also worthy of note.

Anyone who attempts to apply mathematics to economics deserves a hearing. R. claims attention because he definitely has something to say in the matter, although it appears to be addressed largely to experts and those engaged in research, to whom it will no doubt prove valuable; it will not have much appeal to executives or engineers in its present form.

The following errors were noted: On page 26, the dimensions of K should be 1 instead of T^{-1}. On page 112, the sign of the exponential term in equation (2.3) should be positive instead of negative. On page 150, the example of raising potatoes uses 1000 bushels as a basis in one sentence and 1000 pounds in the next. J. B. AUSTIN

Practical Everyday Chemistry. H. BENNETT. Chemical Publishing Co., New York, 1934. 305 pp. Price $2.00. Reviewed in *Power*, **78** [12] 691 (1934).—This is a practical handbook of formulas for everyday laboratory use. F.G.H.

Principles and Applications of Electrochemistry. Vol. II. W. A. KOEHLER. John Wiley & Sons, New York, 1935. 545 pages, 35 tables, illustrated. Price $5.00 net. The manuscript of this book was read by many noted scientists and technologists who are industrially employed and from whom data and illustrations were obtained firsthand. Copious references to the literature are given. K. discusses the science, technology, and economics of the electrochemical production of many industrial products. Ross C. PURDY

Thorpe's Dictionary of Applied Chemistry. Supplement: Vol. II, N–Z. JOCELYN FIELD THORPE AND M. A. WHITELEY. Longmans, Green & Co., London, 1935. xx + 727 pp. Price 60s net. Reviewed in *Nature*, **135** [3427] 7 (1935); for Vol. I see *Ceram. Abs.* **13** [8] 225 (1934). J.L.G.

PATENTS

Concentrating chromite ores by froth flotation. FLOYD WEED. U. S. 2,014,404, Sept. 17, 1935 (Oct. 12, 1932).

Concentrating iron ores by froth flotation. FLOYD WEED. U. S. 2,014,405, Sept. 17, 1935 (Oct. 12, 1932).

Flotation of manganese ores. FLOYD WEED. U. S. 2,014,407, Sept. 17, 1935 (Aug. 26, 1933).

Manufacture of ceramic ware. C. F. GEIGER (Carborundum Co.). U. S. 2,015,750, Oct. 1, 1935 (July 3, 1933). The steps in the process of making a ceramically bonded article from granules at least as hard as commercial glass with the addition of a small proportion of clay and a smaller proportion of water-soluble temporary binder comprise heating the constituents in contact with steam, subsequently mixing the constituents and molding them under the physical conditions produced by so heating the constituents, and finally drying the molded article.

Method of concentrating nonsulfide minerals by froth flotation. FLOYD WEED AND E. E. ELLIS. U. S. 2,014,406, Sept. 17, 1935 (Oct. 12, 1932).

Ore classifier. W. E. ENDREZZE. U. S. 2,015,008, Sept. 17, 1935 (July 8, 1927).

1936 ANNUAL MEETING
American Ceramic Society
COLUMBUS, OHIO
March 29 to April 4

SCHEDULE OF MEETING PLACES

	Saturday Mar. 28	Sunday Mar. 29		Monday Mar. 30		Tuesday Mar. 31		Wednesday Apr. 1		Thursday Apr. 2	Friday Apr. 3	Saturday Apr. 4
	All Day	All Day	Night	All Day	Night	All Day	Night	All Day	Night	All Day		
Trustees	Wallick Suite		President's Reception—Concert—Deshler Ball—8:00	Wallick Suite	Supper—Entertainment—7:30—Deshler Ball	Wallick Suite	Edward Orton, Jr., Lecture—9:00—Deshler Ball	Wallick Suite	Dance—Floor Show—Neil Ball	Wallick Suite		
Trustees and Committees		Deshler A. B. C.										
Art Division				General Meetings—Deshler Ball		Neil Blue		Neil Blue		Extra Division Sessions—Tour of Columbus Claycraft—Enamel—and Glass Factories Ohio State University—Battelle—Orton Lab.	Zanesville Roseville Crooksville	
Enamel Division						Deshler A. B. C.		Deshler A. B. C.			Newark	
Glass Division						Neil Ball		Neil Ball			Newark Lancaster	
Materials and Equipment												
Refractories						Deshler Ball		Deshler Ball				
Structural Clay						Neil Red		Neil Red			Claycraft New Lexington	
Terra Cotta						Neil Garden		Neil Garden			New Straitsville	
White Wares						Neil Jr. Ball		Neil Jr. Ball			Zanesville Crooksville	
Registration		← Deshler Assembly Room →										
								← Neil Mezzanine →				
Publicity and Editorial		← Room 21 Deshler →										
								← Neil Mezzanine →				

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Vol. 19, No. 1, Journal, pp. 1-30 JOURNAL OF THE AMERICAN CERAMIC SOCIETY, JANUARY, 1936 Vol. 19, No. 1, Ceramic Abstracts, pp. 1-30